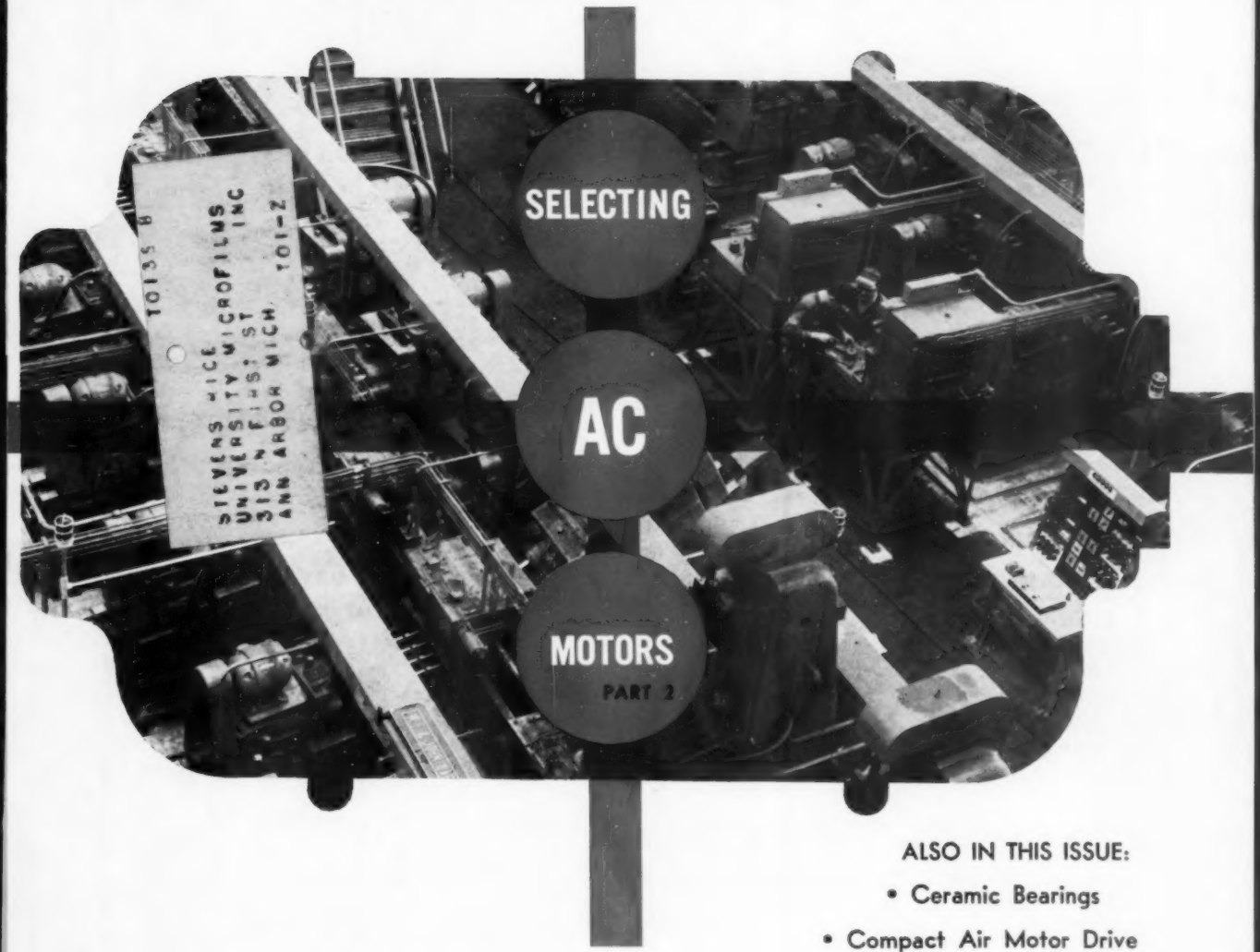
DECEMBER 1960

POWER TRANSMISSION DESIGN

MACHINE DRIVES & COMPONENTS



ALSO IN THIS ISSUE:

- Ceramic Bearings
- Compact Air Motor Drive

INCLUDING BEARINGS DESIGN / APPLICATION

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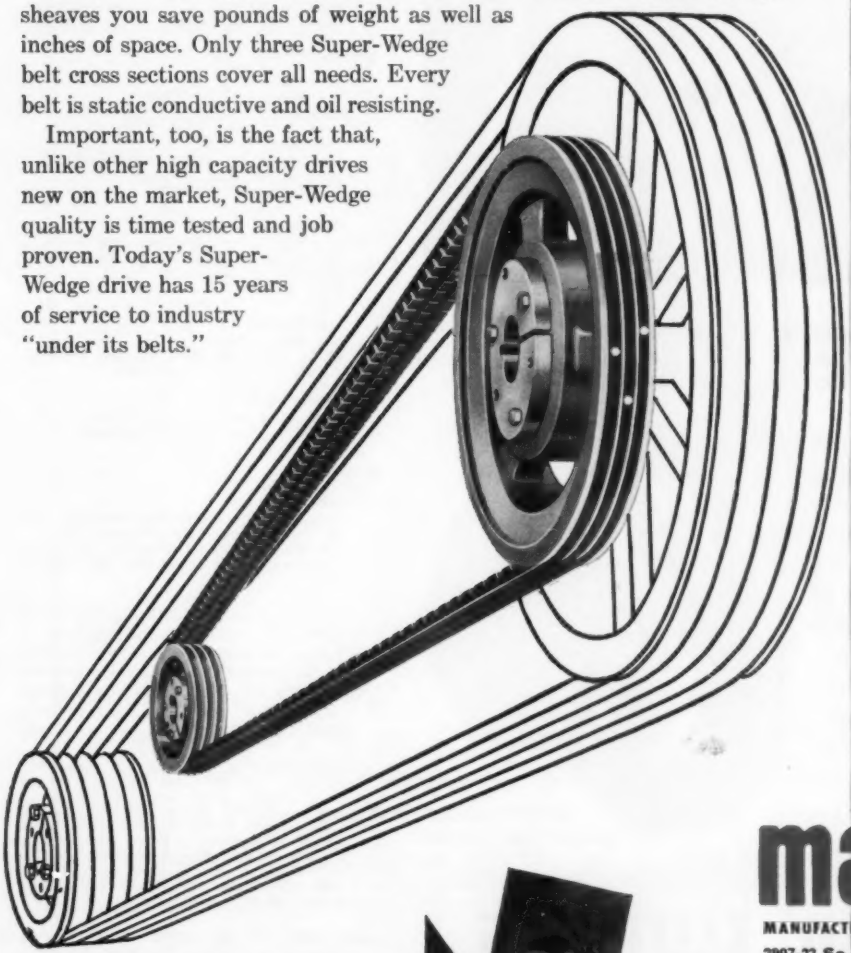

get more **drive**
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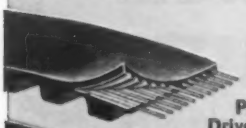
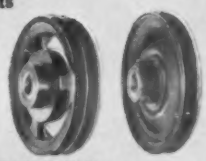


Positive Drive Belts

Variable Speed Belts

Mor-Grip V-Belts



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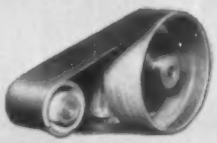

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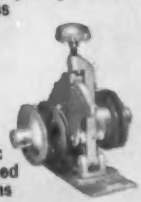

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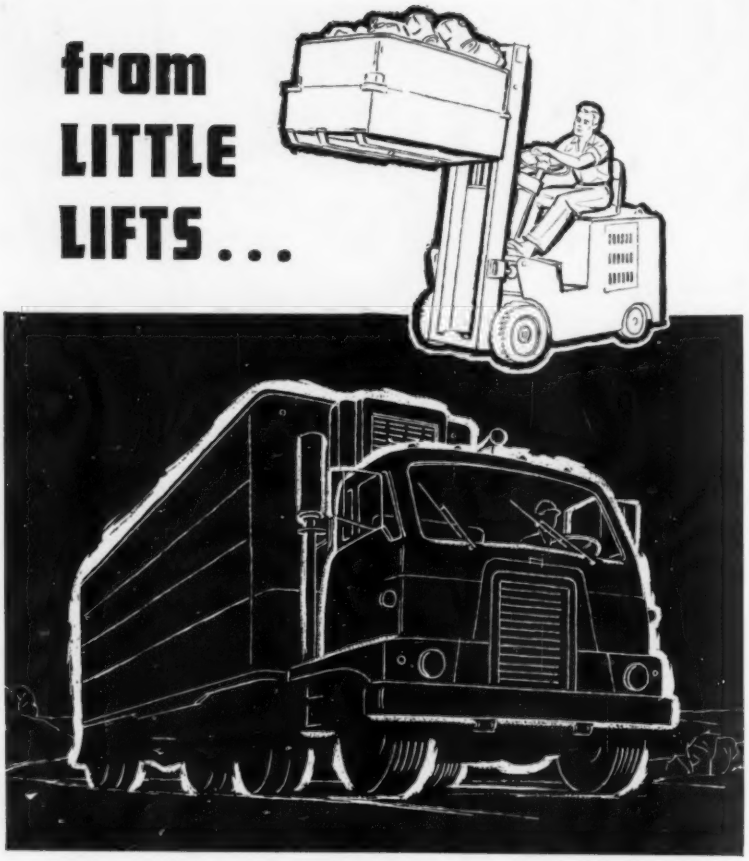

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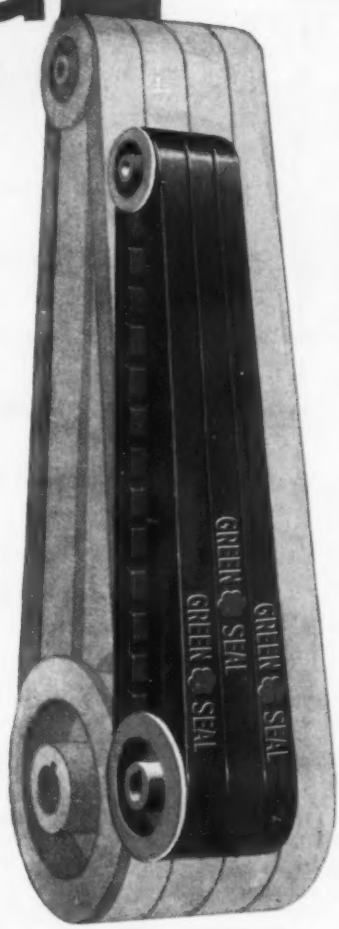
NEW OPENING WEDGE IN YOUR COST-CUTTING CAMPAIGN:

HY-T WEDGE

—a new kind of V-Belt so powerful yet so compact it can cut your drive costs up to 20%

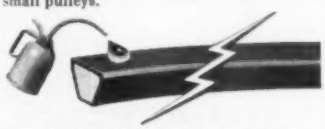


Your V-Belt drive costs have to shrink — with Goodyear quality wedge-type V-Belts like these now at your disposal.

First place, the completely "fat-free" design and rugged construction of a HY-T WEDGE means you can use fewer belts — on smaller sheaves — with shorter centers — to handle any V-Belt job.

You cash in on famed Green Seal quality. Sinewed with exclusive 3-T Cord, every set of these rugged belts will remain a perfectly matched set even through long storage. On the drive, they outlast anything else you can use.

In the larger sizes, the HY-T WEDGE offers rugged, multiple-ply construction. And smaller sizes are notched—another Goodyear feature — for cool-running flexibility over small pulleys.



Still another Goodyear "plus" — every one of the 46 HY-T WEDGE V-Belts is oil-resistant and static conducting. And you don't pay one cent extra for this extra protection.

And remember—these great, new HY-T WEDGE V-Belts are a development of Goodyear—pioneer of the original "wedge" design more than 10 years ago. They incorporate all the advances Goodyear has uncovered in turning out thousands of specialized "wedge" belts for specialized purposes.

For the complete story, check with the G.T.M.—Goodyear Technical Man—through your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Lincoln 2, Neb., or Akron 16, Ohio.

HY-T WEDGE with the GREEN SEAL BY

GOODYEAR

HY-T WEDGE, Green Seal—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio **THE GREATEST NAME IN RUBBER**

Circle No. 18 on Reader Service Card

DECEMBER 1960

volume 2 number 12

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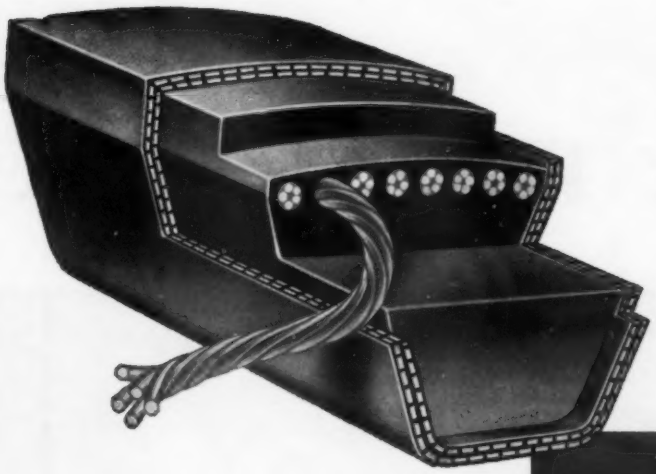
FACTS AT YOUR FINGERTIPS:

Before going further, tear out a Reader Service Card which you will find bound into this issue. Fill it out as you read and mail it when you're done. We'll act on your request immediately.



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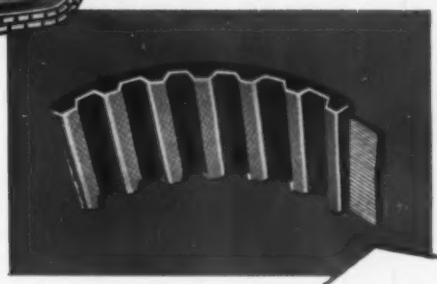
Chain and Gear Benefits with No Metal-to-Metal Contact?

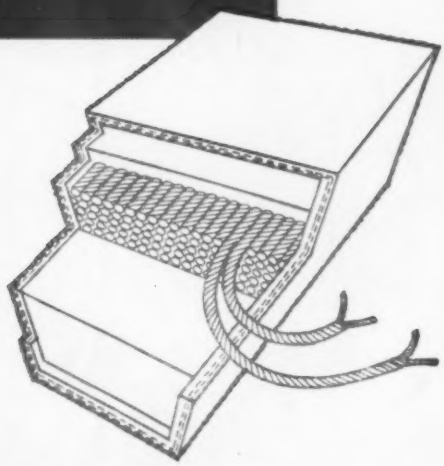
DA POSITIVE DRIVE BELTS. Revolutionary tooth-grip principle; no stretch; no constant lubrication. Highly versatile.



Whatever your V-Belt needs, DURKEE-ATWOOD *meets them*

What do you want in a V-Belt? You want consistent performance, long trouble-free life and full-rated power transmission. That means the belts must be made of the finest quality materials, with careful attention to engineering details, manufacturing processes and testing procedures. Durkee-Atwood V-Belts are made of the newest high tenacity synthetic fibres to assure length stability in storage. The exclusive Durkee-Atwood "Iso-Dynamic" Vertical Matching Machine eliminates the "sag error" that develops when V-Belts are matched on horizontal equipment. This assures equal power transmission from all belts on multiple drives . . . Look to Durkee-Atwood for *quality, service* and *savings ...the most complete line of industrial V-Belts.*

Look for the DA DURKEE ATWOOD *On Your V-Belts*



40% Extra Capacity in Regular V-Belts?

RED SHIELD MULTIPLE V-BELTS. Increased capacity at no increased cost. Available in oil and heat resistant and static dissipating constructions.

Top Performance in Variable Speed Drives?

VARIABLE SPEED BELTS. For constant performance. Abrasion-resistant cover; crowned cross section maintains stability under extreme loads.

DURKEE-ATWOOD V-BELTS

DURKEE-ATWOOD COMPANY MINNEAPOLIS 13, MINNESOTA

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THE MAN & THE GEARING

FROM WESTINGHOUSE

Change gear ratios right in your own plant . . . Mr. Westinghouse† and Moduline gear units bring simplicity and versatility to gearing applications

The modular design of Westinghouse Moduline* drives saves you time and money. Now you can change gears right in your own plant to take advantage of changing manufacturing techniques or improved processes. No more delays . . . Moduline never becomes obsolete, always permits rearranged configuration rather than expensive replacement.

And maybe you've already heard that we've stepped up our application assistance and manufacturing and delivery pace, too. We've moved our entire gearing department to the Buffalo Motor Plant to assure fast and complete coordination on any drive problem you may have. For any drive application, call *your* Man from Westinghouse. He's a drives expert well equipped to represent our Buffalo Division, industry's "controlled torque" headquarters. You can be sure . . . if it's Westinghouse.

†Gil Wilson, Sales Engineer, Hartford Office.

*Trade-Mark

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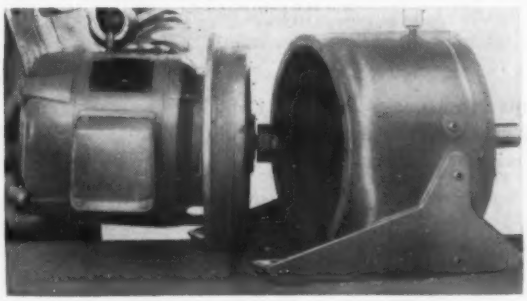

One standard wrench is all you need to modify any Moduline unit. Gear pullers have been completely eliminated, and no special aligning or positioning of modules is necessary during assembly.

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Angular drives clustered in minimum space on stretch reducing mill operate at 8° 10 min. plus or minus.

ANGULAR DRIVE DESIGN

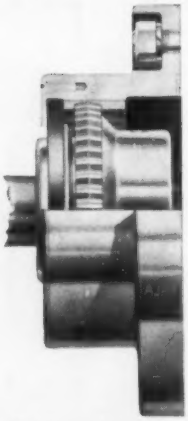
Now Made Easy with AJAX Dihedral Couplings

When your design requires angular drives, the ability of Ajax Dihedral Couplings to permit angular and offset shaft alignment may offer a welcome answer.

The patented tooth design of Ajax Dihedral Couplings now makes possible smooth running angular drives in minimum space.

Double engagement and floating shaft types provide a wide range of adaptability to design requirements. Performance has been proved and approved in thousands of installations involving high torque, adjustability, weaving structures and other difficult conditions.

Feel free to draw on the broad experience of Ajax engineers and sales representatives to aid in working out your problems. Refer to the Yellow Pages under "Couplings" or phone or write...



Cut-away view shows typical arrangement of Ajax Dihedral gears specially designed for handling angular and offset shafts.

AJAX FLEXIBLE COUPLING CO. INC.

132 Portage Road, Westfield, N. Y.

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LETTERS

Address letters to:
The Editor
Power Transmission Design
812 Huron Road, Cleveland 15, Ohio

Fluid couplings and torque converters

There are several points that demand comment in your article "Fluid Couplings and Torque Converters" that appeared in the August 1960 issue of POWER TRANSMISSION DESIGN.

A. Figure 3 shows a peak torque converter efficiency of approximately 72%. Investigation will reveal that this is extremely low for most industrial fixed stator type converters. Maximum torque converter efficiencies in excess of 85% are common in many of our circuits.

B. Figure 3 also indicates that both the converter and coupling reach the race point (unload) at .9 speed ratio or 10% slip. The article, however, correctly implies that slip is usually about 3 to 5% for properly matched units when transmitting full prime mover power. The graph is incorrect, as fluid couplings unload at 1:1 speed ratio.

C. The coupling torque ratio curve in Figure 3 is in error. The torque ratio—defined as the ratio of output torque to input torque—of a fluid coupling is 1:1 throughout its entire range.

D. Equation 1 is given two definitions in your article. It is defined as both "torque capacity" and also "stall torque." $T = CN^2D^5$ is a general relationship of *input* torque or torque capacity of any hydrokinetic device to both the impeller speed and torus diameter. While this relationship affects output torque, the equation cannot correctly be labeled as stall torque. The term "stall torque" is used only for torque converters (versus drag torque for fluid couplings) and is defined as the output torque of the converter when the load is sufficient to stall the turbine. The value of this torque is found by multiplying the absorbed or input torques (according to your formula) by the torque ratio. The equation is basically correct when relating the torque absorption capacity at *all* speed ratios (not just for stall) of identical hydraulic circuits —be they couplings or converters.

TWIN DISC CLUTCH COMPANY
Stan W. Worthington
District Representative

Our comments on the points you've raised follow.

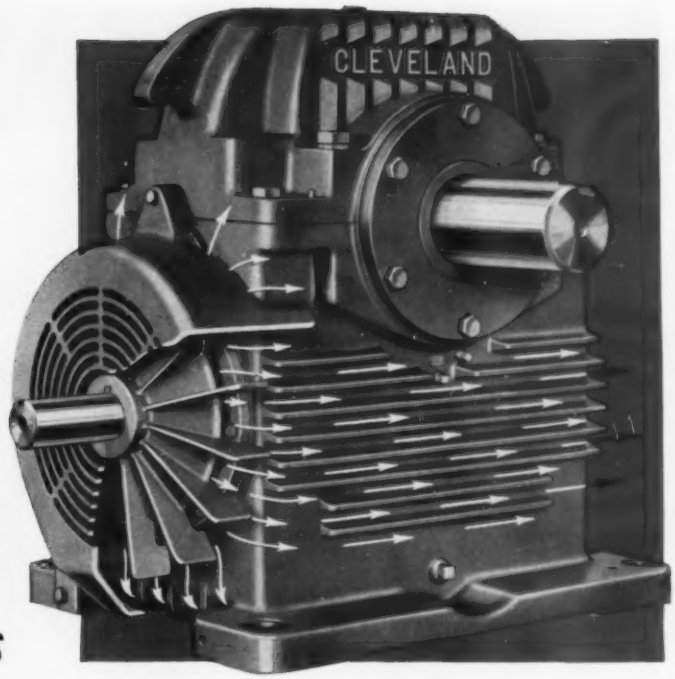
A. Curves in Fig. 3 are, of course, for a particular unit which is not the fixed stator type. We certainly didn't intend our readers to conclude that this was the maximum possible efficiency of any torque converter. Some converters, we know, have higher than 85% efficiency.

B. The reason for this is that some gremlin put the horizontal scale of Fig. 3 so 90% is where 100% should be.

C. You're so right! We hang our heads. Although, this is as supplied by a torque converter manufacturer.

D. A loop means one thing to an airplane pilot and something else to the servo system designer. To us there seems to be a parallel here. And, since you're the hydrodynamic drive expert, we concur.

Thanks for your interest. We're glad to set the record straight.



Fan cooling for Increased HP Capacity is Not New... *to users of Cleveland Speed Reducers*

As far back as 1944, Cleveland Speedaire Worm Gear Reducers (shown in both the announcement ad and cutaway photo below) were providing industry twice the load carrying capacity then available from standard worm gear units of equal frame size. Even then, it was *fan cooling* that did the trick—because fan cooling was and still is the most practical method of heat dissipation.

On the new, higher horsepower Cleveland's (shown in top cutaway photo), a small, specially designed fan—equally effective in either direction of rotation—is located on the worm shaft's input side. Fan size and design permit a smooth, more effective flow of air beneath, above, and around all sides of the reducer.

Mounting the cooling fan on the WORM shaft input end is a very definite Cleveland advantage for when the fan is mounted on the *opposite* side, a second oil seal is needed. This results in additional friction loss due to seal drag—and is another point where oil leakage could occur.

Remember, it was Cleveland design engineers who pioneered both fan cooling and centrifugal casting of bronze gears—and after sixteen years of rugged field usage in all types of industrial plants, have now incorporated these features in all units (from 3 to 12-inch centers) of the new standard Cleveland Speed Reducer line.

Get the story of these new speed reducers from your Cleveland representative, or write today for free 36-page illustrated Bulletin No. 410 that contains complete engineering information. Either way, you will get the answer to improved speed transmission—at savings of 50% or more on per horsepower cost!

A 1944 CLEVELAND AD
"Announcing A Fan-Cooled Worm Gear Speed Reducer ... SPEEDAIRE."

CLEVELAND
Worm Gear
Speed Reducers

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3273 East 80th Street • Cleveland 4, Ohio

Circle No. 7 on Reader Service Card

NEWS *from the power transmission field*

Front engine, rear transmission on Tempest

PONTIAC, MICH.—Pontiac Motor Div's. new Tempest series, a four-door sedan and four-door station wagon, features a rear automatic transmission (transaxle) joined to a front-mounted four-cylinder engine by a flexible propellor shaft. It is said to be the first car in automobile history to use an automatic transmission in this arrangement.

The transmission, a two speed planetary type, has an air cooled, three element torque converter, and works on the split torque principle. In high gear, the drive is split with approximately 40 per cent of the drive straight mechanical and only 60 per cent of the torque going through the converter. This results in solid drive feel and minimum slip or efficiency loss. Transmission, with an automatic upshift, is integrated to the differential carrier with the converter to the rear of the main unit.

Connection with the engine is by a 5/8 in. diameter propellor shaft, made of triple alloy forged steel, heat treated and shot peened for high fatigue life, and curved so that there is virtually no floor-tunnel hump. Housing the shaft is a torque tube of hat sectioned heavy gauge steel that rigidly joins engine and transmission. This curved housing serves to support bearings for the prop shaft, isolates engine torque reaction from engine mounts, permitting use of softer engine mounts.

Battelle Institute programs research on shaft seals

COLUMBUS, OHIO—A major research program into the design and use of high-speed rotary-shaft face seals has just begun at Battelle Memorial Institute. It will be jointly sponsored by "more than a dozen large American manufacturing companies interested in advancing shaft seal technology", according to C. M. Allen, bearing-and-seal specialist at the Institute's research center.

Shaft seals of 50,000 to 100,000 rpm and higher are now built into modern turbocompressors. High-speed seal design and leakage problems have become critical, Allen pointed out, and expensive cut-and-try methods do little for the general improvement of seals. The program is expected to provide valuable data to fill some of the gaps in seal technology.

Principle investigators for the program (scheduled for one year at present) are Frederick K. Orcutt and J. Clarence Bell. They will collect basic experimental data on the behavior of high-speed liquid-lubricated face seals, with special emphasis on primary seal elements. Analysis of this data will allow them to evaluate the various parameters involved.

Battelle has been researching various aspects of wear, friction and lubrication for the past 30 years, and has made many basic studies.

NLGI holds its own elections

KANSAS CITY, MO.—The 27th president of the National Lubricating Grease Institute is F. R. Hart. Supervisor of industrial and marine lubricants for the Standard Oil Co. of California, he was elected to head NLGI next year during the annual meeting at the Edgewater Beach Hotel in Chicago, November 1. He had previously served as vice president and program chairman.

Vice president of the Institute is C. L. Johnson, president of Jesco Lubricants Co., and formerly secretary.

NLGI represents 95% of the manufacturers of lubricating greases and fluid gear lubricants in the U. S. In addition to technical marketing programs, it conducts research and production surveys for its international membership. T. W. H. Miller is the general manager.

Miniaturization Awards 1960 brochure offered

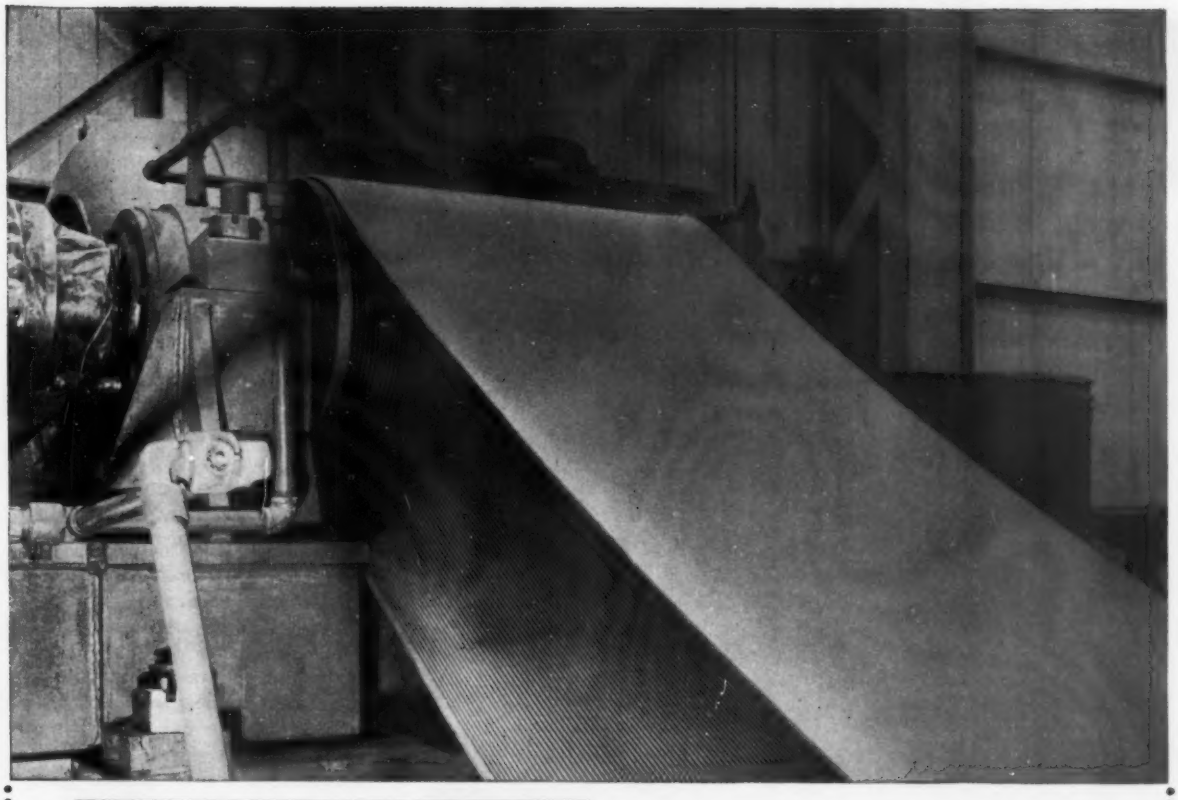
KEENE, N. H.—The Miniaturization Awards Committee has come out with its 1960 Awards brochure. This gives details of the annual inter-industry competition honoring the individual, company or organization who, in the opinion of the judges, has "made the year's most significant contribution to furthering the concept of miniaturization."

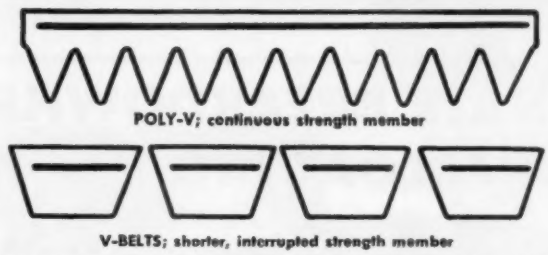
The illustrated brochure contains the history and purposes of the Award, criteria used in judging, and tells how to enter. Previous years' winners are described.

The competition, now in its fourth year, is sponsored by Miniature Precision Bearings, Inc. Copies of the brochure can be had from Horace D. Gilbert, Chairman of the Miniature Awards Committee, Box #604, Keene, New Hampshire.

U. S. Government research reports on bearings

The Office of Technical Services offers a selective bibliography on bearings costing exactly 10 cents. Called SB-410-Bearings it lists research reports over the last 15 years





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Poly-V Belt is a single unit with even, uniform pull. Uninterrupted strength member gives much higher hp capacity per inch of drive width. No belt drive delivers as much power in the same space as Poly-V!

Steel Mill Converts to R/M POLY-V BELT on Rugged Hot-Saw Drive!

A 34½" wide R/M Poly-V® Belt of 92 ribs now delivers "power plus" on this punishing hot-saw drive at one of the country's largest steel works. Converting to Poly-V eliminates the problems of a multiple V-belt drive . . . matching, stretching, overloading, whipping and snapping of individual V-belts.

The patented Raybestos-Manhattan Poly-V Drive is a single unit, V-ribbed belt design that mates perfectly with Poly-V sheave grooves, eliminates V-belt stretch and length matching problems . . . reduces costly machine downtime and production slowdowns for individual belt replacement. Sheave ratio and belt position remain constant from *no* load to *full* load . . . assure smooth, *complete* power delivery under the toughest drive conditions. Poly-V Belt can't sink in the grooves under surges of load. This means less wear on belts and sheaves . . . and much more power in the same space as a multiple belt drive—or equal power in much less space!

Just two Poly-V Belt cross-sections meet every heavy duty drive requirement. Let an R/M representative show you how Poly-V Drive can give you greater power-packed performance and drive dependability . . . "More Use per Dollar" than the drive you now use. Write for Bulletin M141.

RM1020

When You Change Drives . . . Convert to R/M Poly-V Drive and Be Sure!

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MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

ENGINEERED RUBBER PRODUCTS . . . MORE USE PER DOLLAR

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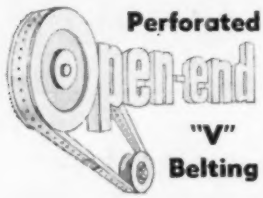
No expensive tools, jigs, or applicators needed!



Buy your V Belts by the foot . . . at much lower cost!

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Available in sizes
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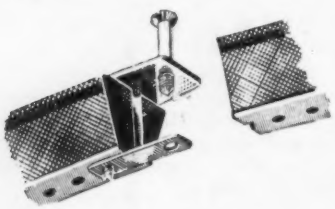
Greater horsepower, less vibration, less stretch, and longer life.



Catalogs and Samples available

Rockwood Pulley Mfg. Co.
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NEW YORK 13, N. Y.

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from the Army, Navy, Air Force, AEC and other government sources, on roller, journal, ball, friction, anti-friction and gas-lubricated bearings. Also includes reports on casting, lubrication, cooling, testing and inspection of bearings.

Philadelphia Gear installs massive hobber

KING OF PRUSSIA, PA.—A new precision gear hobber suitable for gears up to 150 in. diameter and 64 in. face width was recently installed in Philadelphia Gear Corp.'s plant at King of Prussia. It's already at work producing large precision gears for radar and space equipment and heavy machinery industries.

The new hobber is a modified Model No. L-3200, custom-built for Philadelphia Gear by the Liebherr Co. of Kirchdorf, Germany. It was inspected by the Institute for Machine Tools, Technical University, Munich, and certified accurate to 10 arc seconds.

Christian Engineers move; expand facilities

SAN FRANCISCO, CALIF.—J. D. Christian Engineers, with headquarters in San Francisco for more than 36 years, will move its production and design facilities to a new plant in Petaluma. Headquarters remain in San Francisco.

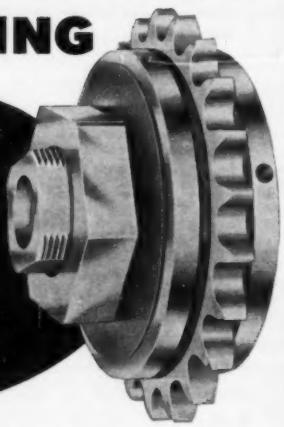
At the same time, president J. D. Christian reported that the firm had bought the machinery and equipment of Standard Metal Products Co., San Francisco. Transfer of equipment from both firms to the new plant is underway.

Waldorf takes over Empire State Laboratories

BELLMORE, N. Y.—Controlling stock interest in Empire State Laboratories, Inc. has been acquired by Helmuth W. Waldorf, who assumes the position of president. Name of the corporation will be changed to Empire Flight Components, Inc., and products will include electro-mechanical speed reducers, devices, miniature differentials, and precision gears.

ELIMINATE BREAKDOWNS due to OVERLOADING

DALTON "OSD" OVERLOAD SAFETY DEVICE
PAT. APPLIED FOR



Ideal for use in conveyors, presses, farm machinery, construction equipment, material handling machines and applications of power transmission equipment.

• ALL STEEL CONSTRUCTION • FEWER PARTS
• TORRINGTON NEEDLE BEARINGS LUBRICATED FOR LIFE

TERRITORIES AVAILABLE FOR DISTRIBUTORS

DALTON gear company
1750 HENNEPIN AVE., MINNEAPOLIS 3, MINN.

Manufacturers of
GEARS
SPROCKETS
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Circle No. 10 on Reader Service Card

Timken completes new piercing mill

CANTON, OHIO—Timken Roller Bearing Co. has completed installation of a new $1 million piercing mill for the No. 3 Tube Mill at the Gambrinus steel plant near Canton. Production capacity averages 10,000 tons per month. The new 38-inch mill replaces the 36-inch installation which has been reconditioned for use in the new No. 4 mill, which began operation in July, 1961. Size range of the latest mill will run from 4½ in. to 12 in. steel diameter with maximum billet size up to 15 ft. in length.

Hewitt-Robins to acquire Union Chain

STAMFORD, CONN.—Hewitt-Robins, Inc. will take over the assets of Union Chain and Mfg. Co., subject to approval by Union Chain stockholders. Announcing the acquisition, Austin Goodyear, president, said that Hewitt-Robins plans to run Union Chain as a division, with E. F. Emmons, former Union Chain president, heading the new division as its president.

MEETINGS

JANUARY 1961

9-13 Society of Automotive Engineers, Annual Meeting, Cobo Hall and Convention Arena, Detroit

17-18 American Society of Lubrication Engineers, Bearing Symposium on design and lubrication of bearings in heavy industry. Penn Sheraton Hotel, Pittsburgh.

FEBRUARY

26-Mar. 2 American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Annual Meeting, Chase & Park Plaza Hotels, St. Louis.

MARCH

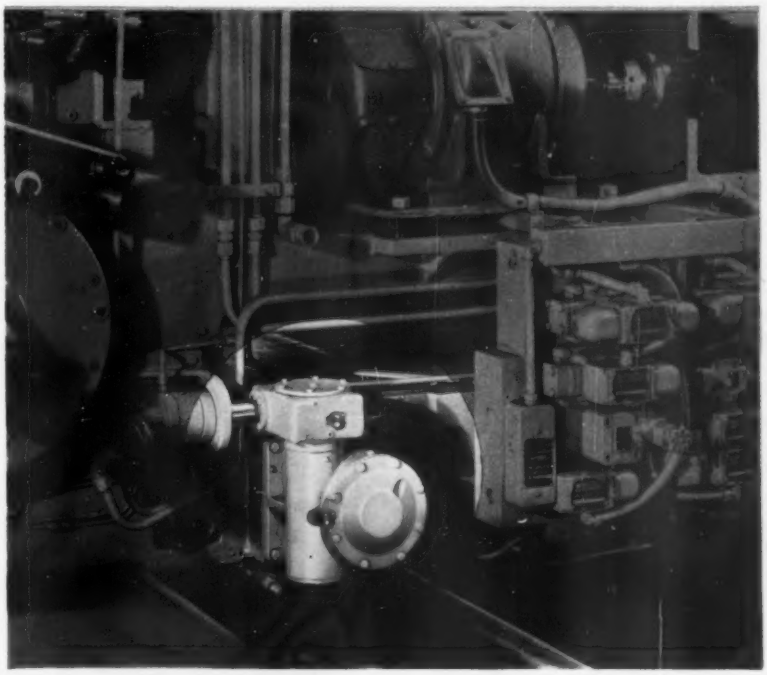
14-16 Society of Automotive Engineers Automobile Meeting, Detroit.

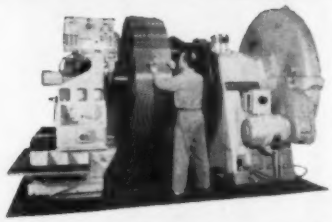
APRIL

4- 7 Society of Automotive Engineers, National Aeronautic Meeting (including production forum and engineering display), Hotel Commodore, New York.

FARREL-BIRMINGHAM SELECTS WINSMITH

for compactness, heavy duty construction, ease of service





Farrel Model 10-T can cut gears having a max. pitch dia. of 120″ with a 24″ face. The generating feed mechanism is controlled by a hydraulic drive through a Winsmith Model 7 CVD Double Reduction Worm Gear Speed Reducer—ratio 120:1—providing maximum flexibility and a wide feed range.

Farrel Gear Generators—manufactured by Farrel-Birmingham—are machines of unusual accuracy and versatility. They are used for mass production, general jobbing and tool room work. Their speed, precision and convenience of operation increase output and decrease costs of generating gears of all types.

Farrel-Birmingham selected Winsmith Worm Gear Speed Reducers because of their compactness, precise heavy duty construction, their ease of maintenance and parts availability. These add up to maximum service—minimum maintenance and downtime.

WINSMITH SPEED REDUCERS

WRITE TODAY for complete selection information and engineering data on the hundreds of Winsmith types and sizes. For every application—from 1/100 to 85 hp., in ratios from 1.1:1 to 50,000:1—you'll find it pays to standardize on Winsmith.

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Circle No. 35 on Reader Service Card

MEN *of the power transmission industry*

United States Rubber elects Vila president

NEW YORK, N. Y.—George R. Vila was elected president and chief operating officer of United States Rubber Co. on October 19. He took up office on November 1, succeeding John W. McGovern, who retires after 40 years with the company. McGovern will remain on the board of directors and executive committee.

Vila's experience covers both technical and sales fields. Holder of an M.S. degree from MIT, he came to U. S. Rubber in 1936 as a salesman for rubber chemicals. In 1942, he transferred to research and development, and as manager of the department, pioneered the development of GR-S rubbers. He also initiated the adaptation of statistical control methods to the manufacture of synthetic rubber, one of the first examples of statistical quality control to a chemical manufacturing process.

Returning to sales in 1946, he was promoted general sales manager for Naugatuck Chemical Div. in 1949, became general manager of this division and a vice president of U. S. Rubber in 1957, and group executive vice president of the company later in the same year. He is the author of many technical articles on synthetic rubber.

Foote Bros names Kocourek manager

CHICAGO, ILL.—Robert S. Kocourek has been promoted to the newly created post of manager, manufacturing services, of Foote Bros Gear and Machine Corp. Previously factory manager for Plant No. 1, Kocourek's new job will be to coordinate manufacturing functions for all three of Foote's Chicago area plants.

KOCOUREK

CORK

Herbert V. Cork, rejoining Foote after two years as planning manager for the Solo Cup Co., will replace Kocourek as factory manager at Plant No. 1.

Nunlist Worthington's new vice president

NEW YORK, N. Y.—Frank J. Nunlist, formerly a group vice president, takes up the new post of vice president-operations in the Worthington Corp. He'll be responsible for all the company's sixteen domestic operating divisions in ten states, as well as regional engineering and service activities.

NUNLIST

Nunlist became associated with Worthington when the company acquired the L. J. Mueller Furnace Co. in 1954. He later became executive vice president of Worthington's Mueller Climatrol Div. In 1958 he was elected a group vice president.

deKruif appointed v. p. for Warner Electric

BELOIT, WIS.—Jack H. deKruif, previously with Hughes Aircraft Co., has been appointed vice president of marketing and sales for Warner Electric Brake & Clutch Co. He will be in charge of brake and clutch sales for Warner's three major divisions—mobile homes and travel trailers, automotive air conditioning and capital goods.

Ebeling new Dodge director of sales

MISHAWAKA, IND.—Fred J. Ebeling was named director of sales for Dodge Mfg. Corp. with the retirement on November 1 of Harry A. Torson, sales vice president. Torson will continue as advisor and consultant to the company on a part time basis, but Ebeling will have full responsibility for sales. Torson has headed Dodge sales department since 1944.

EBELING

TORSON

Ebeling, who attended Indiana University, has held positions as credit manager and assistant secretary and treasurer for Dodge, before transferring to sales as general sales manager in 1952. He worked closely with Torson in directing the company's growing marketing organization.

Hazard elected director at Raybestos-Manhattan

PASSAIC, N. J.—R. B. Hazard, vice president and sales manager rubber and packings, Raybestos-Manhattan, Inc., was elected director of the Corporation at the directors meeting on October 19.

Hazard started with Raybestos-Manhattan in 1945 as sales representative in Minneapolis, rising to vice president and sales manager of the rubber and packing div. in 1956, after various appointments which included sales manager of the packing div. at Manheim.

Promotions at Johnson Bronze

NEW CASTLE, PA.—Johnson Bronze Co. has named John J. Brice vice president-sales, Thomas S. Acker manufacturing manager and Paul J. Failla superintendent of machine shops.

Link-Belt ups Lambert to asst. general manager

CHICAGO, ILL.—Roy E. Lambert, moving up from production superintendent, is now assistant general manager of Link-Belt Company's ball and roller bearing plant in Indianapolis.

A veteran of 23 years with the company, he started at the former Dodge bearing plant in Indianapolis in 1937, became a sales engineer in the New York office until 1945 when he was switched to the Chicago sales office as a ball and roller bearing specialist.

Hanbery will manage Falk Minneapolis office

MILWAUKEE, WIS.—Don T. Hanbery moves up from sales engineer in the Detroit office to manager of the new Falk Corp. district office in Minneapolis. His territory will cover all of Minnesota and part of northwestern Wisconsin. H. R. Harris, former Falk representative for over 30 years, will be at hand for consultation.

Morse makes Koch regional sales manager

ITHACA, N. Y.—Robert J. Koch is the new southwest regional sales manager for Morse Chain Co. His territory will include Texas, Louisiana, Mississippi, Oklahoma and Southern New Mexico.

KOCH

A member of Morse staff for 30 years, Koch spent a number of years working in Houston before going to Morse headquarters in Ithaca for 5 years of sales administrative work.

FOR OEM

- Controlled single or multiple cycling within a wide range of speed.
- Clutch and brake in a single synchronized unit.
- Adaptable to mounting on crank, cam or drive shaft for flywheel or geared applications.
- Can be used with flywheel, gear or drive spider and mounted outboard or between bearings.
- Constant or variable clutch torque.
- Compact, space-saving, easily installed.
- Minster Electrical Controls to your requirements.

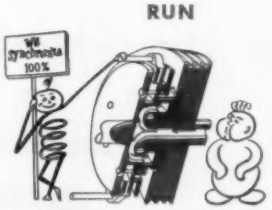
Write for OEM Clutch Bulletin CFC-54.

Combination Clutch and Brake

Air-Operated • Compact

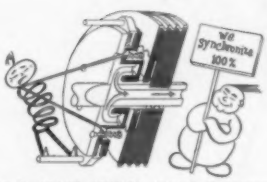
Fast Acting • Perfectly Synchronized

RUN



AIR IN—CLUTCH ENGAGED—(brake off)

STOP



AIR OUT—BRAKE APPLIED—(clutch disengaged)

FOR PRESS CONVERSION

A Minster clutch conversion is the most profitable way to increase press efficiency. It eliminates downtime . . . reduces maintenance and parts replacement . . . increases die life . . . reduces operator fatigue . . . improves safety and increases production.

Minster conversion units, made by a press manufacturer who knows your problems, are standard clutches individually applied to your press. Complete with flywheel and shaft, ready to drop in place. Thousands in daily use.

Write for Clutch Conversion Booklet CC57.

THE MINSTER MACHINE COMPANY · MINSTER, OHIO

MINSTER®

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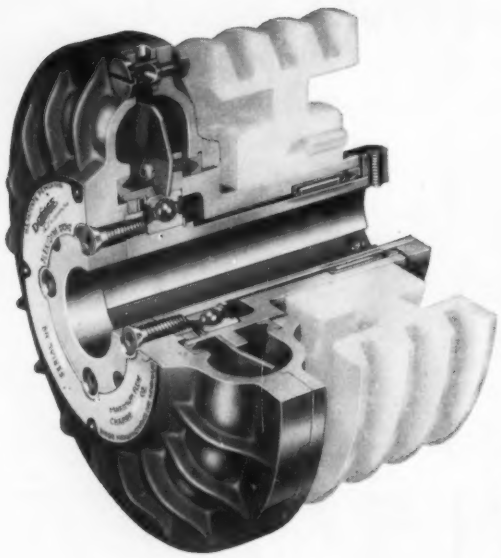
WHAT'S YOUR PROBLEM?...

- ☑ Overheated motors?
- ☑ Excessive belt maintenance?
- ☑ Breakage of materials being processed —like thread, wire, paper?
- ☑ Expense of oversize or high torque motors?
- ☑ High demand rate?
- ☑ Expense of reduced voltage starters?
- ☑ Clutch trouble?
- ☑ Breakage of transmission parts due to instantaneous shock loads?
- ☑ Damage and recurring down-time from overloads?



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THE DRY FLUID DRIVE

It is no longer necessary to accept the destructiveness—the costliness—of conventional starting in the mechanical transmission of power. Flexidyne changes that!

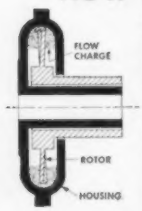
Flexidyne is the new way to start loads *smoothly*—to protect against shock and overload—to save power—all *without any sacrifice of efficiency at full load!*

This revolutionary development is ushering in "the day of the soft start"—which can mean thousands of dollars to you in equipment savings and in better, more economical operation.

Flexidyne is available, off the shelf, in Drives and Couplings. Capacities range from fractional to 1,000 hp. Ask your local Dodge Distributor or write us for technical bulletin.

DODGE MANUFACTURING CORPORATION, 8200 Union St., Mishawaka, Ind.

HOW FLEXIDYNE WORKS



The "dry fluid" in Flexidyne is tiny heat-treated steel shot. A measured amount, called the "flow charge," is contained in the housing, which is keyed to the motor shaft. Inside the housing is a rotor, free to revolve relative to the housing, but connected to the load.

When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor, which transmits power to the load. Initial slippage is momentary. Housing and rotor become locked together and achieve full load speed without slip and at 100% efficiency.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

DODGE

of Mishawaka, Ind.

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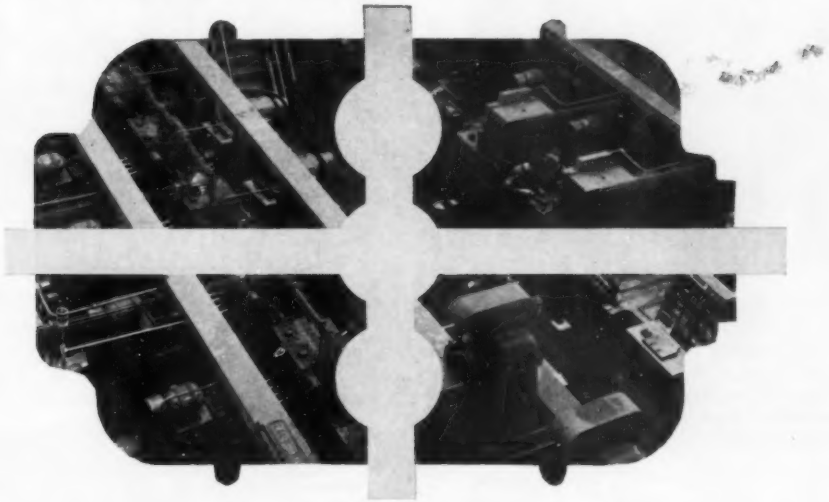
POWER
TRANSMISSION
DESIGN DECEMBER 1960

AC Motor Selection



Part 2—Characteristics of Single-Phase Types

• *Types* • *Sizes* • *Applications*

SINGLE-PHASE MOTORS are, in most cases, similar in design and construction to polyphase squirrel cage or wound rotor motors. But, a single-phase stator winding cannot produce a rotating magnetic field. However, it would keep the motor running once it started. There's a real variety of types of single-phase motors. This variety comes from the many different ways to start them. The types are:

1. Shaded pole
2. Split phase
3. Capacitor start
4. Permanent split capacitor
5. Two-value capacitor
6. Repulsion
7. Repulsion-start induction
8. Repulsion induction
9. Synchronous
10. Universal
11. Servo motors

Single-phase motors are not made in as large sizes as polyphase types. Upper limit is about 20 hp. And, a very high percentage of single-phase motors are less than 5 hp.

Because of the additional complication involved in getting them started, single-phase motors are larger and heavier, in most instances, then polyphase motors of equal power. They also cost more on the same basis, and may be somewhat more prone to failure, because of the additional components in the starting system.

Single-Phase Squirrel-Cage Motors

The first 5 types in the preceding list are this kind. Starting methods, characteristics, and differences among them will be discussed.

Shaded Pole: Simplest of all squirrel-cage, single-phase motors, this design uses a single turn of heavy wire on each stator pole, Fig. 1, to produce an out-of-phase magnetic field component. This out-of-phase component yields the necessary revolving magnetic field for starting.

The starting torque is low, Fig. 2, and efficiency of these motors is low. They are, therefore, made only in very small sizes where these factors are not as important as first cost. Some of their usual applications are: small fans, toys, small motion picture projectors, etc. Direction of rotation is determined by location

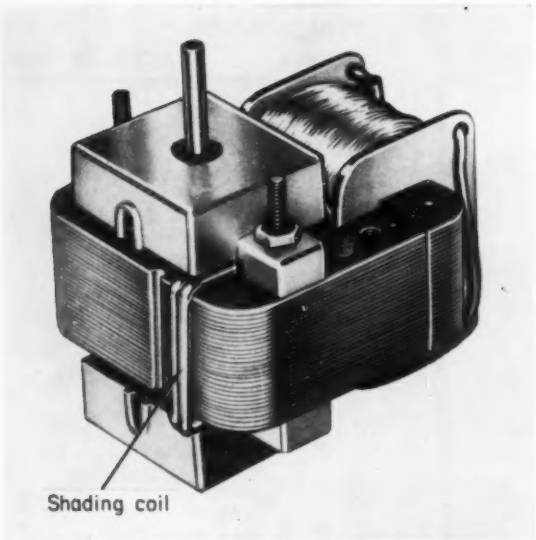


FIGURE 1. The shading coil produces an out-of-phase magnetic field to start the shaded-pole motor. Many shaded pole motors are, like this one, built without enclosure for building into a machine. Photo, courtesy The General Industries Co.

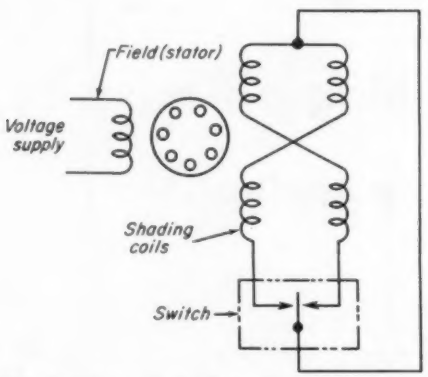
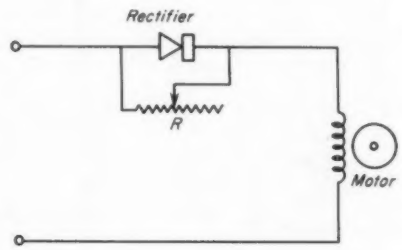


FIGURE 3. To get a shaded-pole motor to start and run in both directions, two sets of shading coils must be used, as shown in this diagram. A single-pole, double-throw switch is used to short the appropriate shading coil. Diagram, courtesy Barber-Colman Co.



(a)

FIGURE 4. Speed can be controlled on a shaded-pole motor by putting a rectifier in one of the supply lines and shunting it with a rheostat, *a*. The effect of increasing resistance is to put more dc into the field and electrically load the motor to shift the speed-torque curve as show at *b*. Courtesy, Barber-Colman Co.

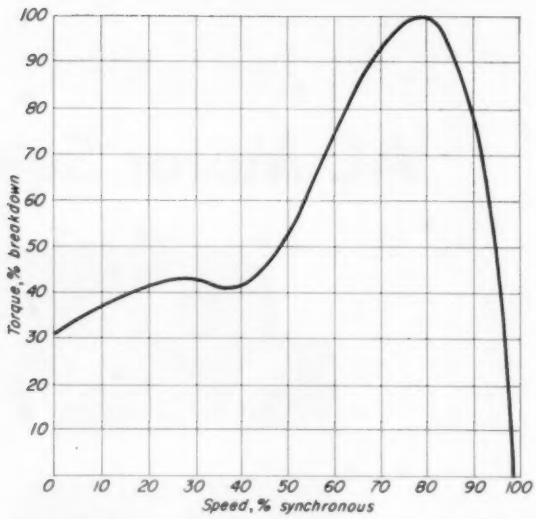


FIGURE 2. Typical speed-torque curve for a shaded-pole motor.

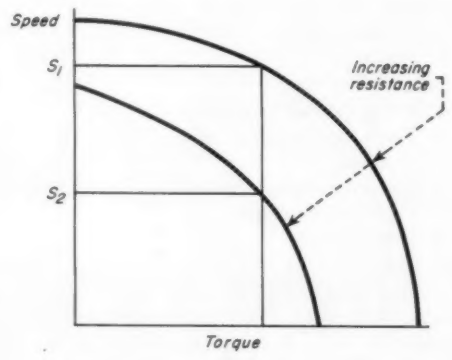
AC MOTOR SELECTION *continued*

of the shading coil. Therefore, they cannot be reversed unless pairs of shading coils and external switching are used, Fig. 3.

Control is simple. The motor is simply connected across the line for starting. Speed may be adjusted with an inductance or resistor in series with the running winding when the load torque requirement decreases with speed. Of course, this further reduces the overall efficiency.

Another method of speed control is to introduce a controlled amount of dc in the field coil. This can be done by putting a rectifier in the power line and shunting it with a rheostat, Fig. 4. This acts like a load on the motor and shifts the speed-torque curve to give lower speeds as resistance increases to increase the amount of dc in the field.

These motors are available for operation on the usual power frequencies of 25, 50, and 60 cps. Operating voltages may be from 6 to 220. Most common voltage is, of course, 115.



(b)

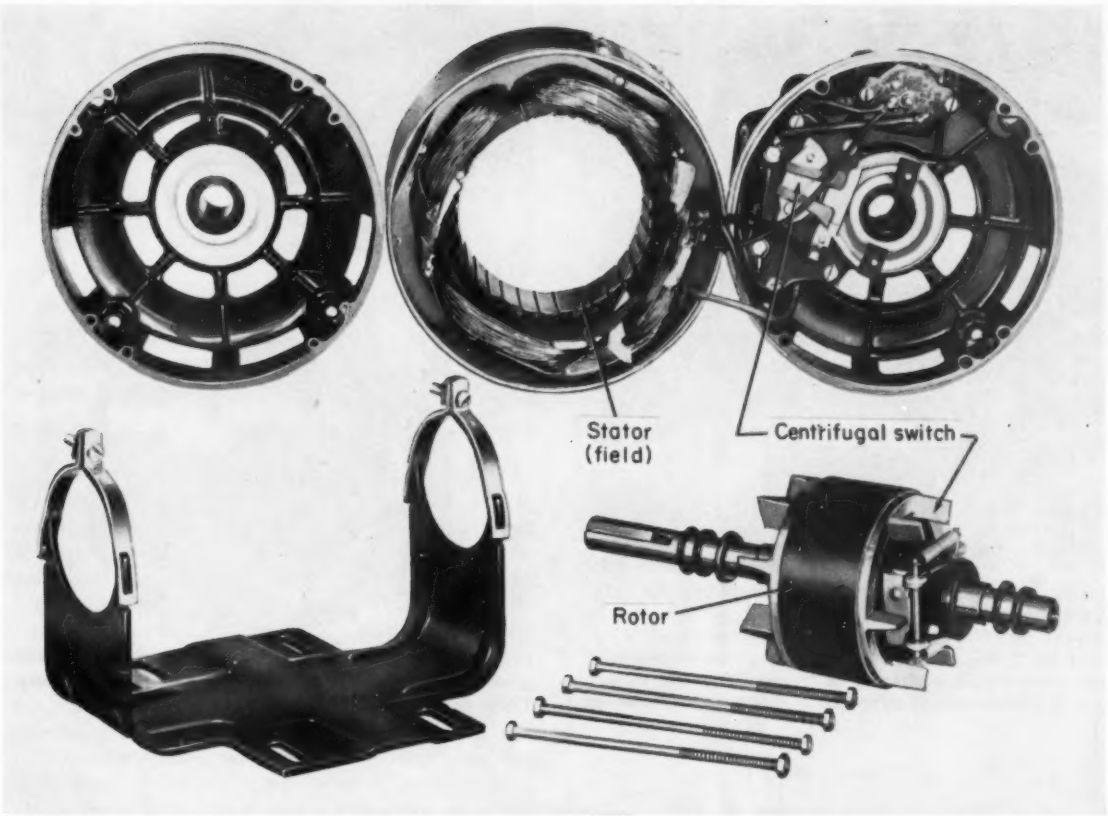


FIGURE 5. Split-phase motor rotor assembly shows the centrifugal switch mechanism used to disconnect the starting winding at about 75% synchronous speed. Photo, courtesy Emerson Electric Mfg. Co.

Split phase: The rotating magnetic field necessary for starting is created by using two stator windings. One is displaced magnetically from the other by making the starting or auxiliary winding with higher resistance than the main winding. The ratio of resistance to inductance is different and thus displaces the magnetic field. When the rotor reaches 75 to 80% synchronous speed, a centrifugal switch disconnects the starting winding, Fig. 5.

Like any squirrel-cage motor, maximum speed is limited by the supply frequency. Few, if any motors of this type are built for operation on higher than 60 cps ac. Starting torque is approximately 150% full-load torque. Typical performance curve is shown in Fig. 6.

Resistance start: This is a split-phase motor with a resistor connected in series with the starting winding to give the same phase displacement as a high-resistance winding. Again, the starting winding is disconnected by a centrifugal switch when synchronous speed is approached.

Capacitor start: This motor uses a capacitor in series with the starting or auxiliary winding to give the necessary phase shift for starting. Starting current is low and starting torque about 200% compared to

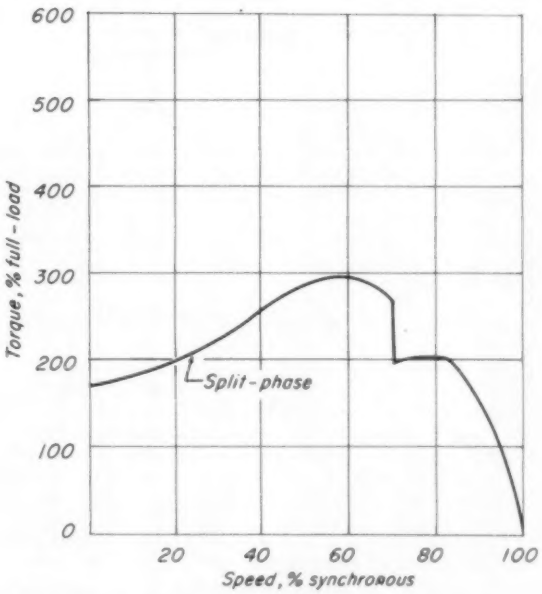
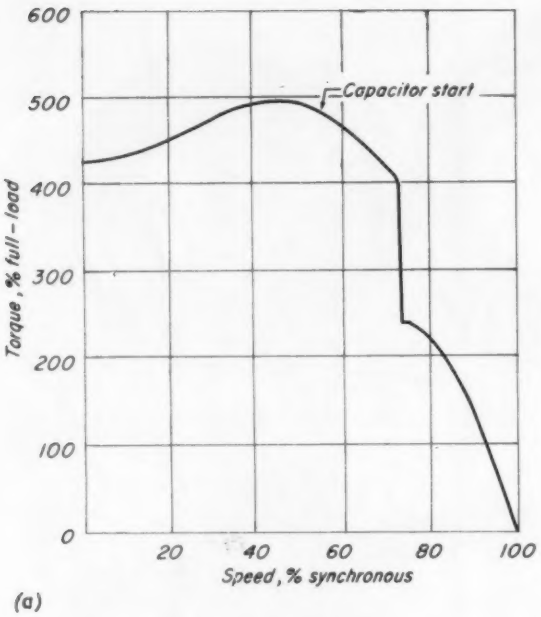


FIGURE 6. Typical speed-torque curve for a split-phase motor. Break in the curve is the point where the centrifugal switch disconnects the starting winding.



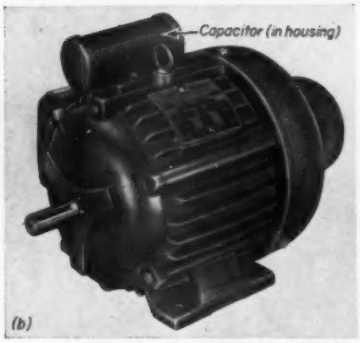


FIGURE 7. Typical speed-torque curve for a capacitor-start motor, *a*. Capacitor in its housing atop the motor, *b*, *c*, is a distinguishing feature of this type of motor as well as the permanent-split capacitor, and two-value capacitor motors. Photo *b*, courtesy Brook Motor Corp. Photo *c*, courtesy Franklin Electric Co.

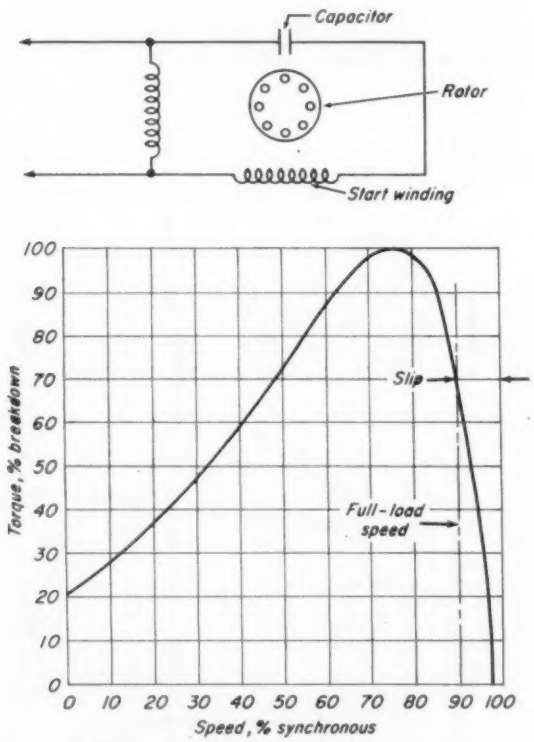


FIGURE 8. Permanent split-capacitor motor has capacitor and running winding in the circuit all the time. Starting torque is low. Courtesy, Westinghouse Electric Corp.

AC MOTOR SELECTION *continued*

the split-phase motor, Fig. 7. A centrifugal switch disconnects starting winding and capacitor at about 75% synchronous speed.

Slip at full-load is about 5% for these motors. They are available for multispeed operation. Otherwise no speed control is used.

These motors are generally made with ratings up to 5 hp. They are commonly used for driving compressors, pumps, refrigerators and blowers. Price, because of the addition of the capacitor is higher than the split-phase motor.

Permanent split capacitor: In these motors, the capacitor and starting winding are in the circuit at all times. Starting torque, Fig. 8, and current are both low.

There is no centrifugal switch used with this type of motor. This contributes to reliability. Quiet operation is a feature. The capacitor in the circuit during operation is responsible for this.

Speed is sometimes controlled with these motors by using two running windings and switching one or the other into the circuit.

Slip at full-load is higher than for the capacitor start motor. Full-load speed corresponding to synchronous speed of 1800 rpm is commonly about 1620 rpm, or slip is 10%, Fig. 8.

Applications best suited to this motor are powering shaft-mounted blowers and fans.

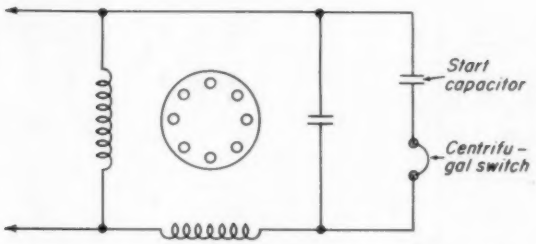


FIGURE 9. Two-value capacitor motor uses one value of capacity for starting, another for running.

Two-value capacitor: One value of capacity is connected in series with the auxiliary winding for starting and another value for running, Fig. 9. Values of capacitors used give good starting characteristics and good running characteristics. These motors are the largest of the single-phase types. They are available to about 20 hp.

Starting current may be controlled by selection of the start capacitor without affecting the running characteristics. However, reducing starting current will also reduce starting torque. Compared to the capacitor-start motor, this one will have slightly better starting torque for equal starting current. Otherwise, its torque speed characteristics are much the same as the capacitor-start motor. Efficiency and power factor are, however, improved by the running capacitor.

As in the case of the permanent-split capacitor motor, the two-value capacitor motor offers quiet running because of the capacitor in the circuit. Slip at full load is about 5%.

Single-Phase Wound-Rotor Motors

Repulsion, repulsion-start induction, and repulsion-induction motors all have wound rotors, commutators, and brushes, Fig. 10. The brushes are connected to displace the magnetic field of the rotor with respect to the stator so there will be torque for starting the motor.

Repulsion: The repulsion motor brushes are short circuited during starting and running. It has a varying speed characteristic much like that of a series motor.

Repulsion motors are rarely used except in adjustable speed applications because of the varying speed characteristic. Speed may be adjusted in two ways. One is by shifting the position of the brushes with some mechanical arangement. The other is by changing the input voltage. In either case, a family of speed-torque curves like those in Fig. 11 results.

The general area of application for this motor is on intermittently-used machines requiring adjustable speed, such as testers.

Continued on page 24

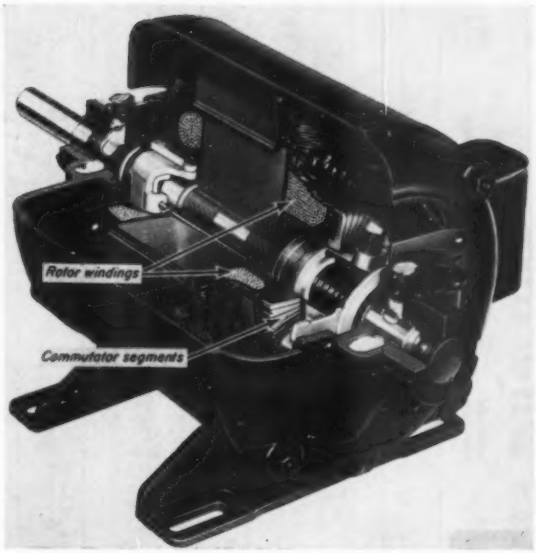


FIGURE 10. Wound rotors, brushes, and commutators are used in single-phase, wound-rotor motors. This unit is a repulsion-start motor, Photo, courtesy Wagner Electric Corp.

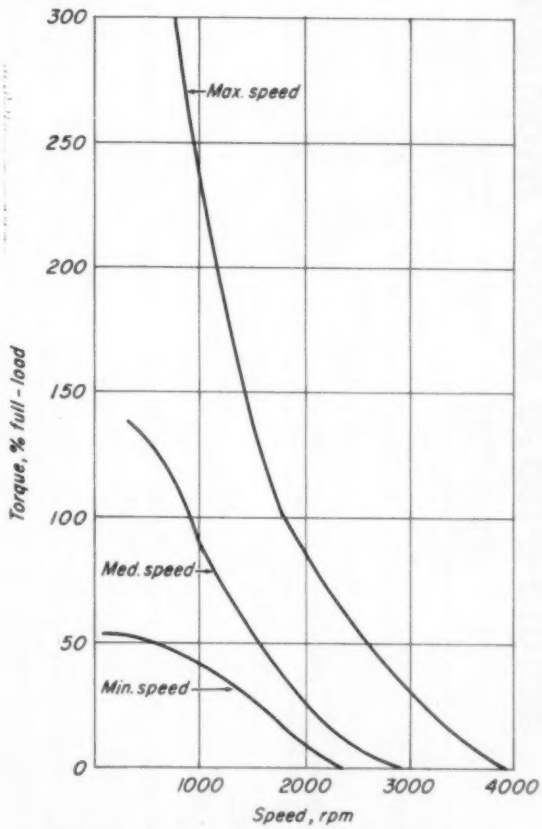


FIGURE 11. Speed-torque curves for a repulsion motor. The three curves are for maximum, medium, and minimum speed positions of the brushes. The same results can be gotten by varying input voltage. Courtesy Reliance Electric and Engineering Co.

Single-Phase Motor Manufacturers Directory

Manufacturer	Shaded pole (hp)	Split phase (hp)	Capacitor start (hp)	Permanent split (hp)	Two-value capacitor (hp)	Repulsion (hp)	Repulsion start induction (hp)	Repulsion induction (hp)	Universal (hp)	Synchronous (hp)	Servo motors (watts)
Air-Marine Motors, Inc. Amityville, L. I., N. Y.				1/500 - 1/3						1/1000 - 1/12	
Louis Allis Co., Milwaukee 1, Wis.			1 - 5		3 - 10						
American Electronics, Inc. Los Angeles 17, Calif.				1/100 - 1/5							
Baldor Electric Co. St. Louis, Mo.								1/6 - 7 1/2			
Barber-Coleman Co., Rockford, Ill.	.0013 - .05		.0019 - .02							.0008 - .0086	
Bodine Electric Co., Chicago Ill.		1/50 - 1/6	1/50 - 1/6	1/1000 - 1/6	1/50 - 1/6				1/100 - 1/4	1/2000 - 1/8	—1/750 hp
R. A. Boehm Co. Merrick, L. I., N. Y.	1/200 - 1/15								1/100 - 1/2		
Borg Equipment Div. George W. Borg Corp. Janesville, Wis.				1/2000 - 1/1500						1/1000 - 1/750	
Brook Motor Corp., Chicago 45, Ill.			1 - 5								
Brown-Brockmeyer Co. Dayton 1, Ohio		✓	✓		✓		✓	✓			
Century Electric Co. St. Louis 3, Mo.		1/20 - 1/2	1/8 - 5		3 - 20		1 - 7 1/2				
Clifton Precision Products Co. Clifton Hts., Pa.											4 - 8
Continental Electric Co. Newark 5, N. J.							1/2 - 7 1/2				
Cramer Controls Corp. Centerbrook, Conn.											
Dale Products Inc., Columbus, Nebr.										1/300 - 1/20	
Delco Products Div. General Motors Corp. Dayton 1, Ohio	1/250 - 1/4	1/12 - 1/3	1/4 - 7 1/2	1/15 - 1/2			1/2 - 7 1/2				
Diehl Mfg. Co., Somerville, N. J.											1 - 15W
Doerr Electric Corp. Cedarburg, Wis.		1/20 - 1/3	1/20 - 7 1/2	1/20 - 2	1 - 7 1/2					1/20 - 2	
Eicor, Inc., Chicago 39, Ill.			—.7						—.2	—1	
Electra Motors, Inc., Anaheim, Calif.			1/2 - 3								
Electric Indicator Co. Stamford, Conn.		1/500 - 1/4	1/500 - 1/4	1/500 - 1/4	1/500 - 1/4				1/400 - 1/4	1/500 - 1/8	
Emerson Electric Mfg. Co. St. Louis 21, Mo.	1/150 - 1/12	1/20 - 1/2	1/8 - 1	1/15 - 1/3							
Fairbanks Morse & Co. Electrical Div., Freeport, Ill.			3/4 - 7 1/2								
Franklin Electric Co., Bluffton, Ind.		1/20 - 1/3	1/20 - 7 1/2	1/12 - 1/2	1/20 - 3						
General Controls Co. Glendale 1, Calif.		1/25 - 1/12									
General Electric Co. Schenectady, N. Y.			1/6 - 5		1/6 - 5						
General Industries, Inc., Elyria, Ohio	1/1800 - 1/35			1/320 - 1/175							
Gleason-Avery, Inc., Auburn, N. Y.	.0006 - .002									.0006 - .002	
Globe Industries, Inc. Dayton 4, Ohio				1/250 - 1/5						1/400 - 1/35	
Hagen Mfg. Co., Inc. Baraboo, Wis.										7 - 10W	
The A. W. Haydon Co. Waterbury, Conn.										.5 - 6W	
Haydon Div. General Time Corp. Torrington, Conn.										2.5 - 6W	
The Hertner Electric Co. Cleveland, Ohio		.03 - .5	.03 - .5	.0025 - .5						.001 - .5	15 - 25
Hoover Electric Co. Los Angeles 25, Calif.		1/10 - 3	1/10 - 3						1/50 - 3		
Howell Electric Motors Co. Detroit 35, Mich.		1/40 - 3/4	1/40 - 7 1/2	1/40 - 3/4		1/2 - 3/4	1/2 - 5				
IMC Magnetics Corp. Westbury, L. I., N. Y.			—1 1/2							1/200 - 1/3	
Imperial Electric Co., Akron, Ohio			1 - 10								

Jack & Heintz, Inc. Cleveland 1, Ohio			1/15 - 7 1/2									
Kearfott Div. of General Precision, Inc. Little Falls, N. J.												✓
Lamb Electric Co., Kent, Ohio				1/100 - 1/4						1/50 - 4	1/50 - 1/12	1/1000 - 1 hp
Lear Inc., Electro-Mechanical Div. Grand Rapids, Mich.				1/60 - 1/8								
Leece-Neville, Georgia Div. Gainesville, Ga.	1/500 - 1/3			1/20 - 1/2								
Leland Ohio Electric Co. Dayton, Ohio			1/3 - 3				1/2 - 3	-5				
Marathon Electric Mfg. Corp. Wausau, Wis.		1/20 - 1/3	1/20 - 3	1/20 - 1/2	5 - 7 1/2							
Marco Electric Mfg. Corp. Womelsdorf, Pa.	1/250 - 1/6			1/100 - 1/3								
The Master Electric Div. Dayton 1, Ohio		1/20 - 1/3	1/8 - 3		1/8 - 3	1/8 - 3/4	1/8 - 7 1/2				1/8 - 1/2	
Molon Motor & Coil Corp. Chicago 18, Ill.	1/1000 - 1											
Motor Specialty, Inc., Racine, Wis.										1/200 - 1 3/4		
National Pneumatic Co., Inc. Holtzer-Cabot Divisions Boston 19, Mass.		1/50 - 1/10	1/50 - 1/2	1/2000 - 1/4	1/20 - 3/4						1/2000 - 1/2	1/1000 - 1/3 hp
Newman Electric Motors, Inc. Newark, N. J.			1 - 5									
Northwestern Electric Co. Chicago, Ill.	1/40 - 1/8					1/4 - 5		5 - 10		3/4 - 2		
Peerless Electric Co. Div. H. K. Porter Co., Inc. Warren, Ohio			1/2 - 10	1/2 - 10	1/2 - 10		1/2 - 7 1/2	1/2 - 7 1/2				
Pesco Products Div. Borg Warner Corp., Bedford, Ohio				.008 - .25								
Rae Motor Corp., Racine, Wis.										1/60 - 3/4		
Redmond Co., Inc., Owosso, Mich.	1/500 - 1/3			1/30 - 1/3								
Reliance Electric & Engineering Co. Cleveland 17, Ohio		1/20 - 1/3	1/8 - 3		1/8 - 3	1/8 - 3/4	1/8 - 7 1/2				1/8 - 1/2	
Robbins & Myers, Inc. Springfield 99, Ohio	✓	1/100 - 1	1/100 - 20	1/100 - 1						1/50 - 1	✓	
Rotating Components, Inc. Brooklyn 22, N. Y.			1/2000 - 1/4	1/2000 - 1/4							1/2000 - 1/10	1/2000 - 1/100
Shelby Electric, Inc., Shelbyville, Ind.			1/16 - 5								1/16 - 1/2	
Skurka-Langdon Engineering Co. Los Angeles 32, Calif.		1/1000 - 1		1/1000 - 1							1/1000 - 1/2	
Small Motors, Inc., Chicago, Ill.	1/500 - 1/40	1/100 - 1/8	1/100 - 1/8							1/1000 - 1/4	1/100 - 1/40	
A. O. Smith Corp., Tipp City, Ohio		1/4 - 1/3	1/4 - 5	1/4 - 1/3								
Speedway Mfg. Co. Div. of Thor Power Tool Co. La Grange Park, Ill.	.0003 - .002									.05 - .2		
Standard Electric Div. Standard Dayton Corp. Dayton 1, Ohio			1/8 - 5	1/8 - 1		1/8 - 5						
Sterling Electric Motors, Inc. Los Angeles 22, Calif.			3/4 - 3									
Telechron Motors General Electric Co., Ashland, Mass.											2 - 12W	
Transicoil Div., Daystrom, Inc. Worcester, Pa.												.5 - 7W
Uppco, Inc., Chicago 7, Ill.	1/300 - 1/35											
U. S. Electrical Motors, Inc. Los Angeles 54, Calif.			1/4 - 1									
Universal Electric Corp. E. Owosso, Mich.	1/200 - 1/6			1/20 - 1/3						1/100 - 1/10		
Valley Electric Corp., St. Louis, Mo.							1/2 - 7.5					
Wagner Electric Corp. St. Louis 14, Mo.		1/6 - 1/3	1/6 - 3		1 - 10		1/6 - 15	1 - 5				
Western Gear Corp., Lynwood, Calif.				.003 - 5								
Westinghouse Electric Corp. Buffalo 5, N. Y.			1 - 20								1 - 20	
Wincharger Corp., Sioux City 2, Iowa										1/10 - 1		

✓ indicates company makes this type of motor, but size could not be determined by press time.

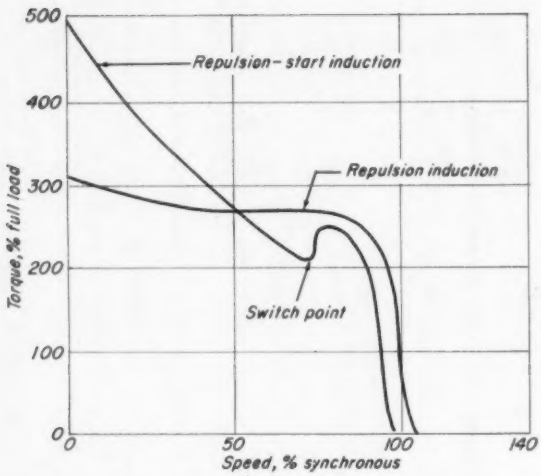


FIGURE 12. Speed-torque curves of repulsion-induction and repulsion-start induction motors compared. Courtesy Peerless Electric Div., H. K. Porter Co., Inc.

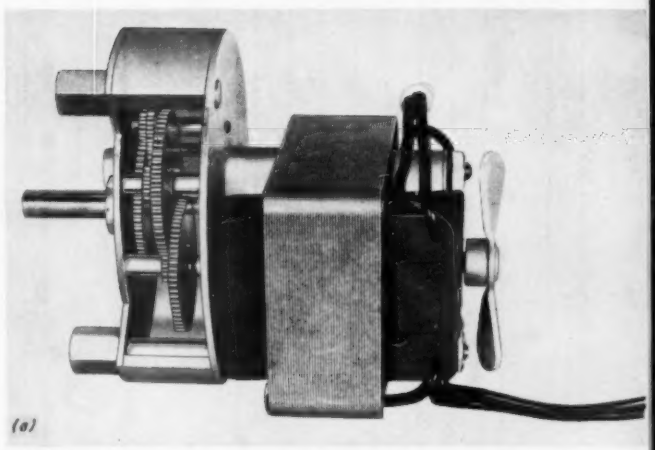


FIGURE 13. Some typical small synchronous motors, ordinarily used for timing applications. Units *a* and *b* incorporate gear trains. Photo *a*, courtesy Gleason-Avery, Inc. Photo *b*, courtesy Clock and Timer Dept., General Electric Co. Photo *c*, courtesy Dale Products Co.

AC MOTOR SELECTION *continued*

Repulsion-start induction: Construction is much like the repulsion motor. As full-load speed is approached, all the commutator segments are shorted to effectively convert the rotor windings to a squirrel cage. The motor then runs as an induction motor. In some designs, the brushes are lifted off the commutator at the same time the segments are shorted. This eliminates wear on the brushes when they are not functioning anyhow.

High starting torque and low starting current are outstanding characteristics of repulsion-start induction motors. Starting torques range from 400 to 700% of full-load torque. A typical speed-torque curve is shown in Fig. 12. Full-load slip is about 5%.

Repulsion-induction: Both a repulsion motor winding and a squirrel-cage winding are used on this type. Characteristics vary depending on the characteristics of the two windings.

Starting torque is high and torque does not decrease much until 85% synchronous speed is reached. At these higher speeds, the motor runs as a squirrel cage motor even though the commutator bars are not shorted. In fact, no centrifugal device is used to make any sort of reconnection.

Unlike all the other ac motors so far mentioned, the repulsion-induction motor will run above synchronous speed at no load, and full-load speed may equal synchronous speed, Fig. 12.

Where fast reversing (plugging) is required, these motors give smooth reversals without excessive heating. For this reason, they are often recommended for use on door, window, and valve operators, as well as small hoists.

The repulsion-induction motor is used in many applications in the 3 to 15 hp range where a NEMA Design B or C squirrel cage would be used if polyphase current were available. They are also used, in some instances, where a wound-rotor motor might be used. Typical applications are: air compressors, conveyors, fans, and centrifugal pumps.

Single-phase Synchronous Motors

There are two kinds of single-phase synchronous motors. They are:

1. Synchronous reluctance
2. Synchronous hysteresis

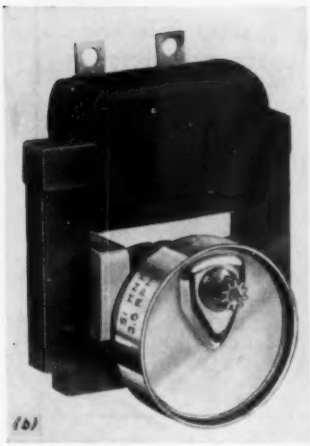
All of these units are built for very small power ratings and are used where exact speeds are needed. For example in electric clocks and recording meters. Hysteresis motors are also used for phonograph turntable drives. Some typical units are shown in Fig. 13.

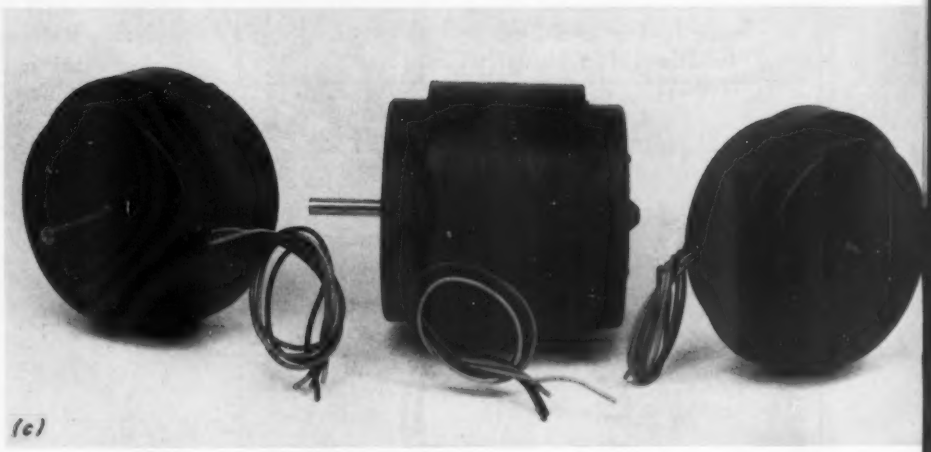
Universal Motors

The universal motor is a commutator type with armature and field windings in series. The name universal stems from the fact that it is intended for use on both ac and dc. Its design is such that it will operate on ac up to 60 cps with almost the same characteristics, Fig. 14, as on dc.

Useful full-load speeds for these motors are high —5,000 to 10,000 rpm. They are very light and compact. Most frequent uses are in intermittently operated portable devices like vacuum cleaners, drills, saws, and household mixers. They have a varying speed characteristic and speed is easily adjustable.

Universal motor parts—stator, rotor, and brush mechanism without end shields, bearings, or frame—are commonly available for building into things like home mixers and power tools.





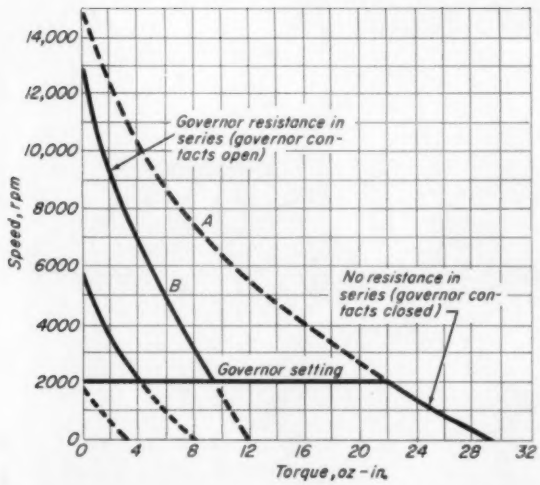


FIGURE 14. Speed-torque characteristics for a small universal motor. These curves were prepared to show how speed can be controlled by inserting resistance in series with the motor to shift the speed-torque curves. These motors may be governed by using a centrifugal switch to insert resistance in the circuit as speed increases or take it out when speed drops. Courtesy, Bodine Electric Co.

Servo Motors

A servo motor is basically a split-phase motor with the leads for both phases brought out so they may be connected independently. One phase winding is called the fixed phase and has constant voltage and frequency applied to it. The other winding is called the control winding since a controlling voltage is applied to it.

The control voltage is often supplied by an electronic amplifier. Since many electronic amplifiers use a push-pull output stage which must be coupled to a winding with an electrical connection at its center, servo motors may provide this connection on the control phase. Otherwise, a transformer would have to be used to connect the amplifier and servo motor. The servo motor control winding may also be wound to

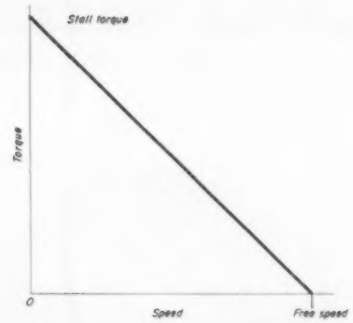


FIGURE 15. Speed-torque characteristic of servo motors is ideally the straight line shown here. Courtesy Transicoil Div., Daystrom, Inc.

provide the correct impedance match for the amplifier.

Servo motors are designed as closely as possible to have a linearly sloping speed-torque characteristic, Fig. 15. Another design objective is to have stall torque directly proportional to the voltage applied to the control phase.

Because of the careful analytical design of servo systems, servo motor manufacturers provide as figures of merit for these motors:

1. Torque constant—Proportionality factor relating stall torque to control phase voltage.
2. Moment of inertia of the servo motor rotor.
3. Time constant—A measure of acceleration rate of the motor. Equals time to reach 63.2% free speed when full power is applied to both phases.
4. Reversing time—Time to reach 63.2% free speed in the reverse direction when voltage on the control phase is reversed.

Other performance evaluation data such as: Frequency response, theoretical acceleration at stall, viscous damping, and the motor transfer function.

Sizes and ratings: Servo motors are made in very small sizes, Fig. 16. Output is usually expressed in terms of stall torque and free speed, or watts. Typical ratings are from 5,000 to 10,000 rpm speed with stall torques from 0.2 to 3.0 oz-in. Gear reduction is often used to get higher torques at lower speeds.

Table I—Hp and Speed Ratings of Fractional-Hp Induction Motors*

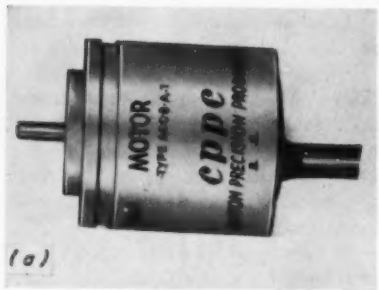
Hp	Sync. Speed @ 60 cps (rpm)	Full-Load Speed @ 60 cps All motors* (rpm)	Perm. split cap. (rpm)
1, 1.5, 2, 3,	3600	3450	———
5, 7.5, 10, 15,	1800	1725	———
25, 35 millihp	1200	1100	———
1/20, 1/12, 1/8	3600	3450	———
	1800	1725	———
	1200	1140	———
	900	850	———
1/6, 1/4, 1/3	3600	3450	———
	1800	1725	———
	1200	900	———
1/2	3600	3450	3250
	1800	1725	1625
	1200	1140	1075
3/4	3600	3450	3250
	1800	1725	1625
1	3600	3450	3250

*Except shaded pole and permanent split capacitor less than 1/3 hp.

Table II—Ratings for Shaded Pole and Permanent Split Capacitor Motors Less Than 1/3 Hp

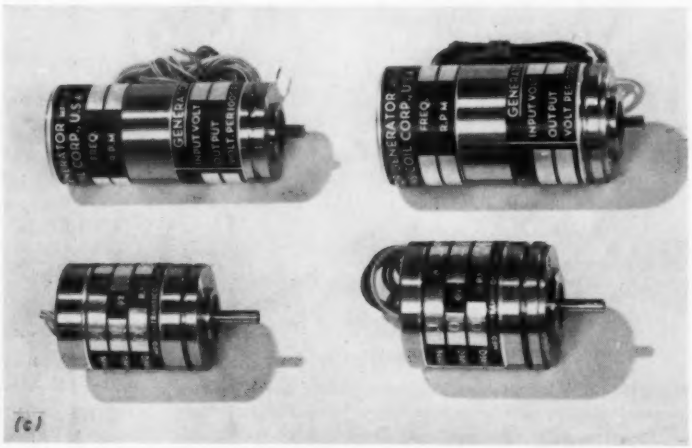
Hp	Speed, synchronous @ 60 cps (rpm)	Approximate full-load speed @ 60 cps Shaded pole (rpm)	Permanent split capacitor (rpm)
1, 1.25, 1.5,	3600	———	3000
2, 2.5, 3, 4,	1800	1550	1550
5, 6, 8, 10,	1200	1050	1050
12.5, 16, 20, 25, 30 and 40 millihp	900	800	800
1/20, 1/15, 1/12,	3600	———	3250
1/10, 1/8, 1/6,	1800	1550	1625
1/5, 1/4, 1/3†	1200	1050	1075
	900	800	825

†Does not apply to shaded pole motors



(a)

(b)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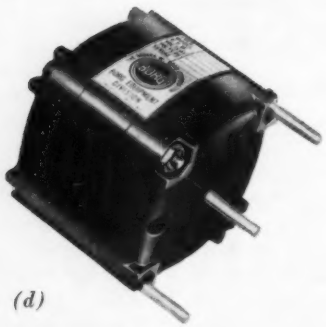
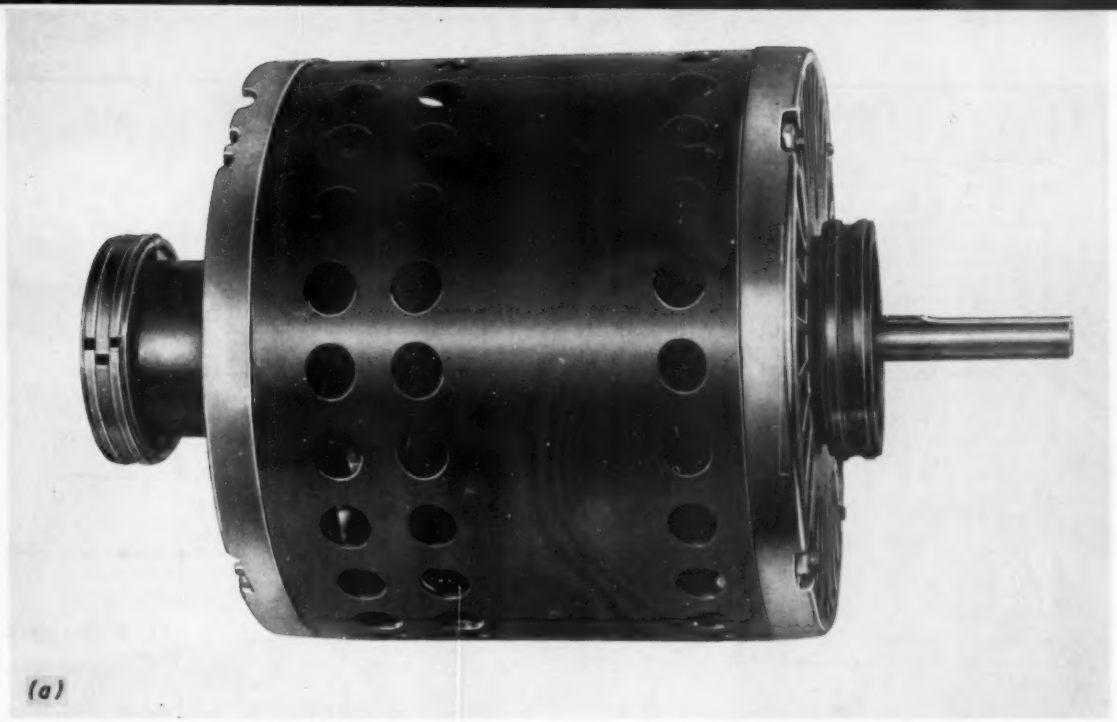
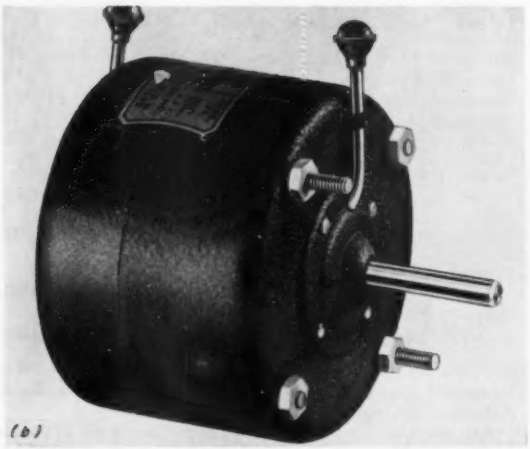

(d)

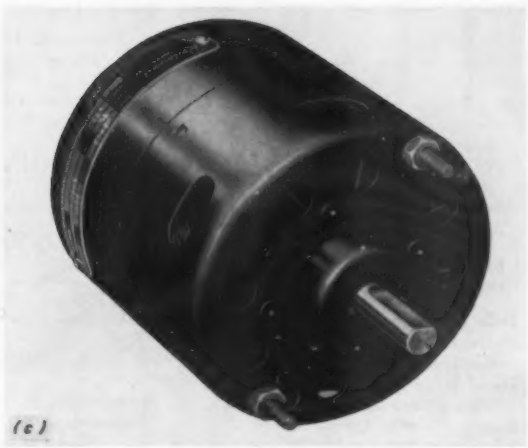
FIGURE 16. Some typical servomotors. These motors are usually face mounted and supplied with pigtail leads. Photo *a*, courtesy Clifton Precision Products Co., Inc. Photo *b*, courtesy Holtzer-Cabot Motor Div., National Pneumatic Co., Inc. Photo *c*, courtesy Transicoil Div., Daystrom, Inc. Photo *d*, courtesy Borg Equipment Div., Amphenol-Borg Electronics Corp.



(a)



(b)



(c)

FIGURE 17. Appliance motors, *a*, are often mounted resiliently with end rings to minimize vibration and noise. Photo, courtesy Delco Products Div., General Motors Corp. Small motors, *b* and *c*, are often mounted by threaded studs or extended through bolts. Photo *b*, courtesy Small Motors, Inc. Photo *c*, Redmond Co., Inc.

AC MOTOR SELECTION *continued*

Voltages may vary from about 25 to 300 volts. Frequencies of the applied voltage are usually either 60 or 400 cps.

NEMA Specifications

NEMA (National Electrical Manufacturers Association) has standards applying to many of the types of motors discussed. Of course, these do not encompass all possible variations and sizes. But, they are an indication of what is most commonly available. See Tables I and II.

Also included in the NEMA Standards are standards for motors used for certain definite applications. Table III was compiled from these, and shows areas of application for many of the single-phase motors discussed in this article.

Mechanical Variations

Types of enclosures and mountings for single-phase motors are the same as those for polyphase motors, in sizes covered by NEMA standards. However, those having less than 1 hp may be designed for mounting in quite different fashion than the typical industrial motor. Fig. 17. ▼▼▼

Table III—Single-Phase Motor Applications*

Split Phase

Belt-driven fans (1/4-1/3 hp, 1 or 2-speed)
Coolant pumps (Fhp)
Hermetic refrigeration condensers
Jet pumps (Fhp)
Oil burners (1/12, 1/8, 1/6 hp)
Shaft-mounted fans (1/20 hp up, Fhp)
Submersible pumps (deep wells)
Sump pumps (1/3 hp)
Washing machines, dryers, mangles (1/6, 1/4, 1/3 hp)

Repulsion-Start Ind.

Belt-driven fans (1/3-3/4 hp)
Belt-driven refrigeration compressors (1/4-3/4 hp)
Coolant pumps (Fhp)
Gasoline pumps (1/2 hp)
Jet pumps (Fhp)

Shaded pole

Air conditioning condensers and evaporator fans (Fhp)
Shaft-mounted fans (Fhp)

Capacitor Start

Belt-driven refrigeration compressors (1/6-3/4 hp)
Belt Driven fans (1/3-3/4 hp, 1 or 2-speed)
Coolant pumps (Fhp)
Gasoline pumps (1/2 hp)
Hermetic refrigeration condensers
Jet pumps (Fhp)
Washing machines, dryers, mangles (1/6, 1/4, 1/3 hp)

Permanent Split Capacitor

Air conditioning condensers and evaporator fans
Hermetic refrigeration condensers
Shaft mounted fans (Fhp, 1/20 up)

Two-value capacitor

Hermetic refrigeration condensers (Fhp)

* From NEMA Definite Purpose Motor Standards

Acknowledgment

Co-operation of the following companies in providing information for use in this article is acknowledged with thanks.

Air-Marine Motors, Inc. ..... Amityville, L. I., N. Y.
Louis Allis Co. ..... Milwaukee 1, Wis.
American Electronics, Inc. ..... Los Angeles 17, Calif.

Barber-Coleman Co. ..... Rockford, Ill.
Bodine Electric Co. ..... Chicago, Ill.
R. A. Boehm Co. ..... Merrick, L. I., N. Y.
Borg Equipment Div.
George W. Borg Corp. ..... Janesville, Wis.
Bristol Motors Div.
Vocaline Co. of America, Inc. .. Old Saybrook, Conn.
Brook Motor Corp. ..... Chicago 45, Ill.
Brown-Brockmeyer Co. Inc. ..... Dayton 1, Ohio

Century Electric Co. ..... St. Louis 3, Mo.
Clifton Precision Products Co. ..... Clifton Hts., Pa.
Cramer Control Corp. ..... Centerbrook, Colo.

Dale Products Inc. ..... Columbus, Nebr.
Delco Products Div.
General Motors Corp. ..... Dayton 1, Ohio
Diehl Mfg. Co.
Div. Singer Mfg. Co. ..... Somerville, N. J.
Doerr Electric Corp. ..... Cedarburg, Wis.

Eicor, Inc. ..... Chicago 39, Ill.
Electra Motors, Inc. ..... Anaheim, Calif.
Electric Indicator Co. ..... Springdale, Conn.
Electro Counter & Motor Co. ..... Chicago, Ill.
Emerson Electric Mfg. Co. ..... St. Louis 21, Mo.

Fairbanks Morse & Co.
Electrical Div. ..... Freeport, Ill.
Franklin Electric Co. Inc. ..... Bluffton, Ind.

General Controls Co. ..... Glendale 1, Calif.
General Electric Co. ..... Schenectady, N. Y.
General Industries Co. ..... Elyria, Ohio
Gleason-Avery, Inc. ..... Auburn, N. Y.
Globe Industries, Inc. ..... Dayton 4, Ohio

Hagen Mfg. Co., Inc. ..... Baraboo, Wis.
Hansen Mfg. Co., Inc. ..... Princeton 10, Ind.
The A. W. Haydon Co. ..... Waterbury, Conn.
Haydon Div.
General Time Corp. ..... Torrington, Conn.
The Hertner Electric Co. ..... Cleveland, Ohio
Hoover Electric Co. ..... Los Angeles 25, Calif.
Howell Electric Motors Co. ..... Detroit 35, Mich.

IMC Magnetic Corp. ..... Westbury, L. I., N. Y.
Imperial Electric Co. ..... Akron, Ohio

Jack & Heintz, Inc. ..... Cleveland 1, Ohio

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Marco Electric Mfg. Corp. ..... Womelsdorf, Pa.
The Master Electric Div. ..... Dayton 1, Ohio
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Motor Specialty, Inc. ..... Racine, Wis.

National Pneumatic Co., Inc.
Holtzer-Cabot Divisions ..... Boston 19, Mass.
Newman Electric Motors, Inc. ..... Newark, N. J.
Northwestern Electric Co. ..... Chicago, Ill.

Peerless Electric Co.
Div. H. K. Porter Co., Inc. ..... Warren, Ohio
Pesco Products Div.
Borg Warner Corp. ..... Bedford, Ohio

Rae Motor Corp. ..... Racine, Wis.
Redmond Co., Inc. ..... Owosso, Mich.
Reliance Electric and
Electric Co. ..... Cleveland 17, Ohio
Robbins & Myers, Inc. ..... Springfield 99, Ohio
Rotating Components, Inc. ..... Brooklyn 22, N. Y.

Shelby Electric, Inc. ..... Shelbyville, Ind.
Skurka-Langdon Engineering Co. Los Angeles 32, Calif.
Small Motors, Inc. ..... Chicago, Ill.
A. O. Smith Corp., Electric Motor Div. . Tipp City, Ohio
Speedway Mfg. Co. Div. of
Thor Power Tool Co. ..... La Grange Park, Ill.
Standard Electric Div.
Standard Dayton Corp. ..... Dayton 1, Ohio
Sterling Electric Motors, Inc. .... Los Angeles 12, Calif.

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General Electric Co. ..... Ashland, Mass.
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Uppco, Inc. ..... Chicago 7, Ill.
U. S. Electrical Motors, Inc. .... Los Angeles 54, Calif.
Universal Electric Corp. ..... E. Owosso, Mich.

Valley Electric Corp. ..... St. Louis, Mo.

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This huge 42" Twin Disc Air Clutch has a torque capacity of 166,800 lb.-ft.

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Small wet or dry clutches in 3.5" and 4.5" sizes with capacities to 14 hp. Enclosed units in sizes from 5.5" to 11.5" and capacities from 14 to 112 hp. Large heavy-duty clutches for high-torque duty; sizes to 36" and capacities to 1050 hp.

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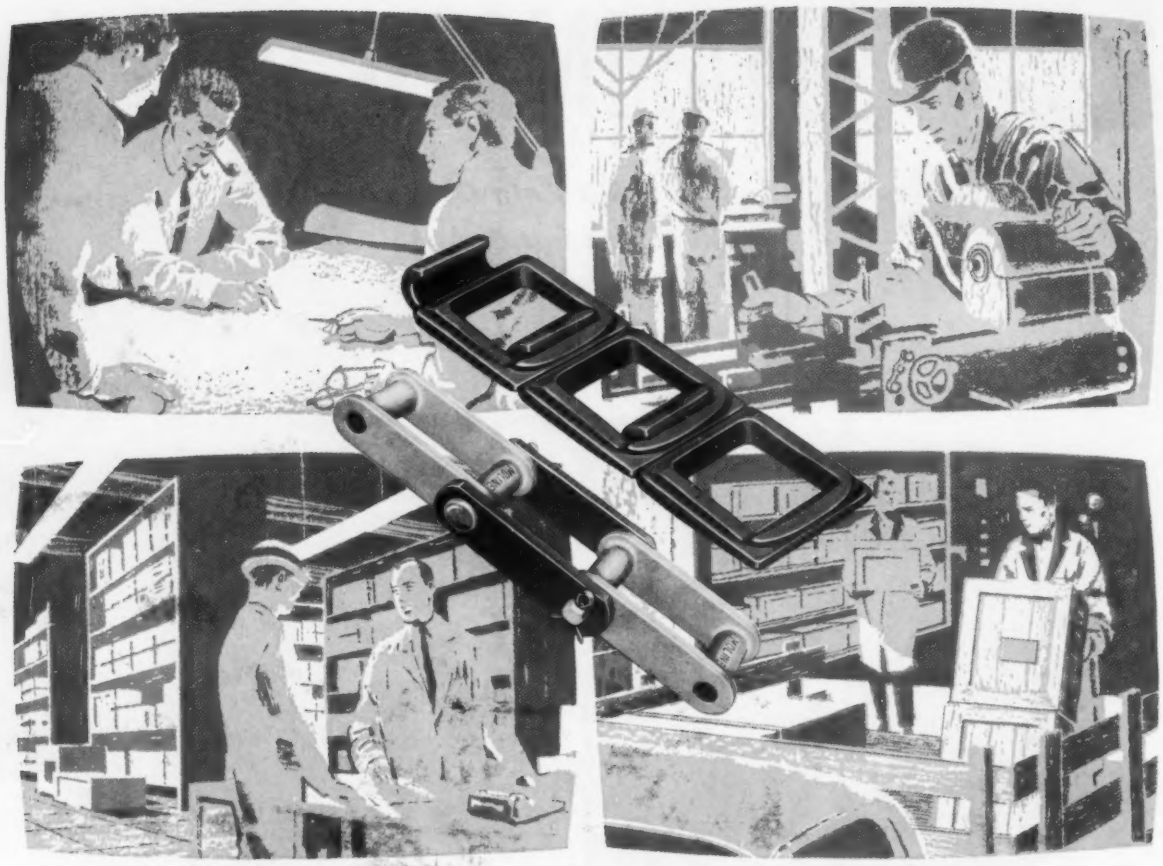

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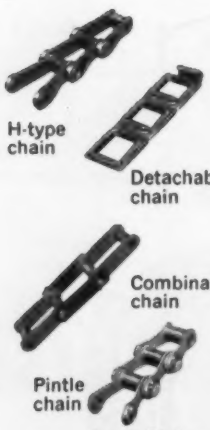

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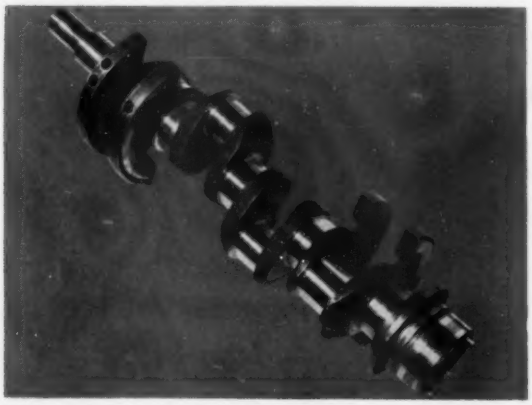
DESIGN
IDEAS
FROM THE FIELD

Metallizing gives worn parts new life

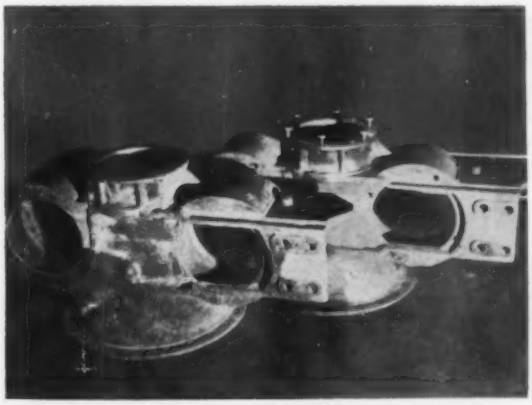
WORN COMPONENTS in power transmission systems often can have their lives extended by metallizing, where a new metal surface is sprayed on the part.

It's being done successfully by the Philadelphia Transportation Co., which operates buses, trolleys, and subways in Philadelphia. PTC rebuilds gears,

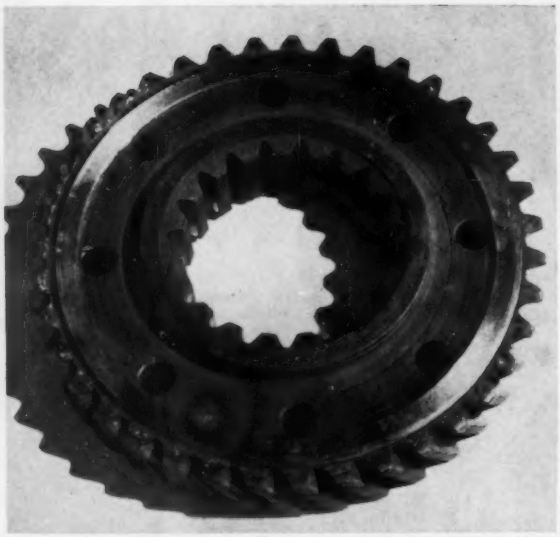
Left to right: 2 GMC oil seal bearings; governor shaft bearing; trolley car trunnion; center—bus torque conversion gear. Metallizing makes them good as new.



Bus crankshaft weighs 100 lb, costs $10 to metallize.



Rear axle bearing housing has 6 in. bearing bore.



Eight inch bus torque conversion gear before re-building. Note worn bearing surface which causes wobble and side play.

IDEAS
continued

bearing surfaces, drive shafts, crankshafts, compressor and pump shafts, axles, rods, pistons, flanges, brake shoes, and trolley car trunnions used in its vehicles.

Metallizing not only saves money by stretching the lives of these items, but also provides a better working fit than new parts, says Dale Keddie, shop foreman. A completely new replacement may not fit exactly, because of wear in the assembly.

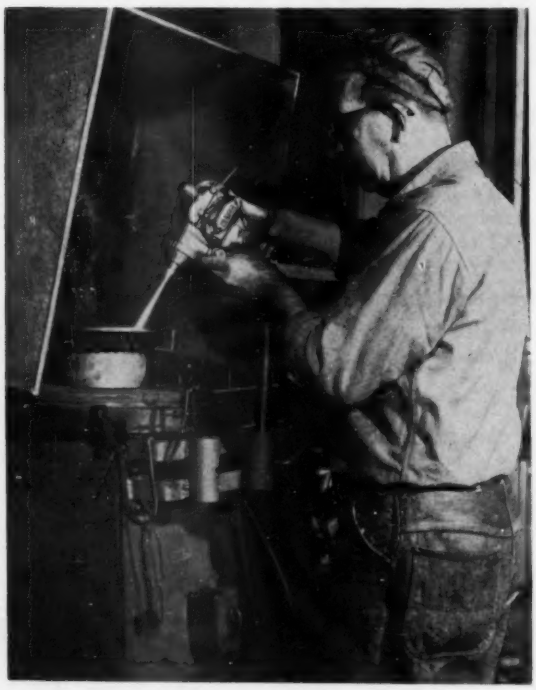
The shop metallizes with all the common metals and their alloys, including steel, aluminum, lead, zinc, tin, nickel, bronze, chrome, molybdenum, and copper. The metal, in wire form, is vaporized by an oxy-acetylene flame and sprayed through metallizing guns by compressed air.

Generally, a worn surface is prepared by grit-blasting, filing, or—if it is cylindrical—by rough-threading on a lathe. A metal mask is then clamped to the part to protect areas where no buildup is wanted and the part is sprayed. Sometimes the prepared part is preheated before spraying to prevent stresses between old and new metal. After metallizing, the part is machined or ground to final dimensions.

The metallizing equipment at PTC consists of three guns and associated gas cylinders and controls, a hooded metallizing chamber, and a grit-blasting chamber. It takes about 30 sq. ft. of floor space. Maintenance requires weekly lubrication and an annual teardown to inspect for wear. One man can do a typical rebuilding job.

PTC formerly used welding and brazing for similar rebuilding. However, many parts couldn't be reclaimed by these processes, and those that could

Steel grit is used for blasting.



Spraying with molybdenum alloy wire.

had to be heat-treated to restore hardness that excessive welding or brazing heat drew off. Metallized parts don't have to be heat-treated.

A typical rebuilt part is a large gear used to convert and transmit torque in buses. This gear has a diameter of 8 in. and weighs 8 lb. Its bossed bearing surface wears, permitting side-play and wobble.

The worn surface is grit-blasted in a special chamber with a nozzle using steel grit. This takes 5 to 15 minutes. The part is then sprayed with molybdenum alloy wire for about 15 minutes. Finally, the surface is precision ground to a coating thickness of .025 in. PTC estimates the refinishing cost at $5.

PTC normally reworks bearing surfaces on its bus crankshafts in .010-in. steps, with appropriate bearing adjustment to each cutting. When the bearings are down .050 in., the entire surface is rebuilt by metallizing to the original diameter with molybdenum, followed by chrome alloy. The crankshaft is finished on a large grinder.

It costs $10 to metallize a 100-lb crankshaft with crank pins 3 in. in diameter and main bearings 3½ in. in diameter. This includes surface preparation by filing. The rebuilt bearing surfaces last and wear three times as well as the original surfaces, says PTC.

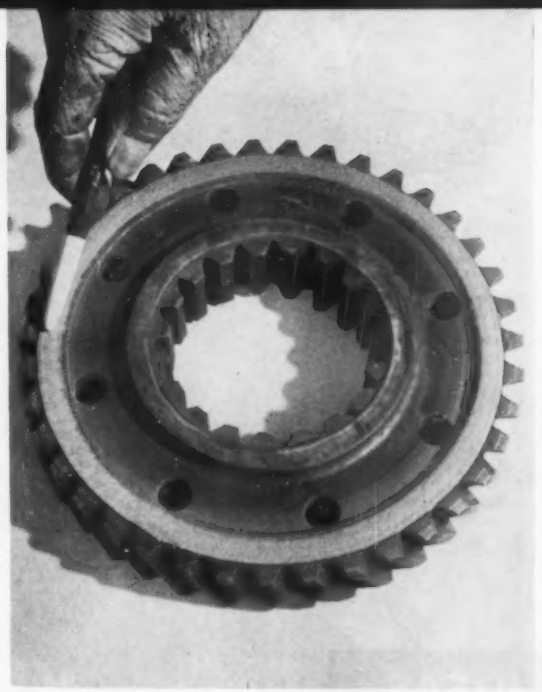
PTC reports similar large savings in the cost of replacing or stocking these items:

- Axle wheel hub, 6 in. wide and 2 in. deep, is metallized for $10.
- Air compressor shaft, which supplies air to the brakes, door, and horn, is chrome-sprayed for $2.50.

Measuring metal build-up before grinding.

- Small flange at the end of the steering mechanism, 1½ in. in diameter and 1 in. long, is metallized in 10 minutes for $1.50. Preparation consists of machining and sand-blasting.
- Rear axle bearing housing for a trolley car is 3½ ft long, 1 ft wide, has a 6 in. bearing bore, and weighs 200 lb.

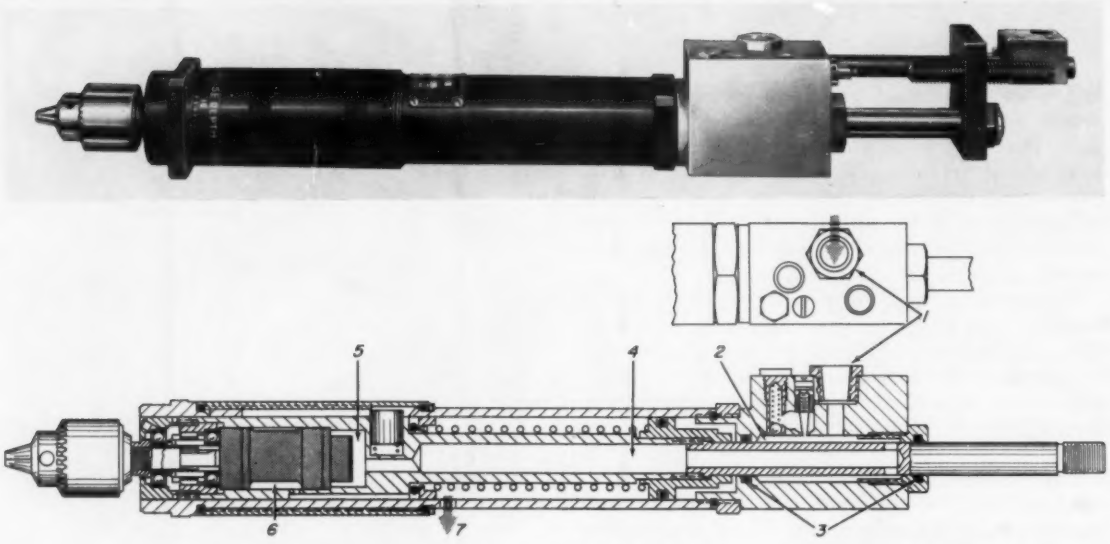
In addition to common metals and their alloys, which are available in wire form, refractory alloys, carbides, ceramics, and cermets are available as powders for similar guns designed for powder spray. ▲▲▲



Mask confines metal build-up to area indicated.

New metal is ground to a coating of .025 in.

Working fit is better than with new parts.



LINE AIR enters at a pipe fitting (1) on top of the rear head, filling the chamber (2) within the head which surrounds the piston rod. Cross-drilled holes in the piston rod connect with the central cavity (4) which terminates in the chamber (5) at the rear end of the motor. From this point, air enters the motor in conventional manner and it exhausts at (6). Slots on the OD of the motor housing convey the exhaust air to the rear and final emission to atmosphere through drilled holes in the tube (7). Seals (3) are provided at either end of the chamber to prevent motor air leakage to either the feed air chamber or to the atmosphere.

IDEAS *continued*

Air motors give compact, efficient drive

ROTARY AIR MOTORS combine economy with efficiency in driving automation tools produced by Buckeye Tools Corp., Dayton, Ohio. These air-driven tools are used in operations requiring both rotary and linear motions, such as drilling, tapping, and fastening.

Rotary motion is supplied by the air motor, linear motion by an air cylinder. By combining the inherent advantages of these motors and cylinders into a single package, the automation tools offer sizable savings, even on low-volume runs. The motor is not bulky or heavy, furnishing a high power-to-weight ratio.

Buckeye Tools lists these specific advantages for the air motor:

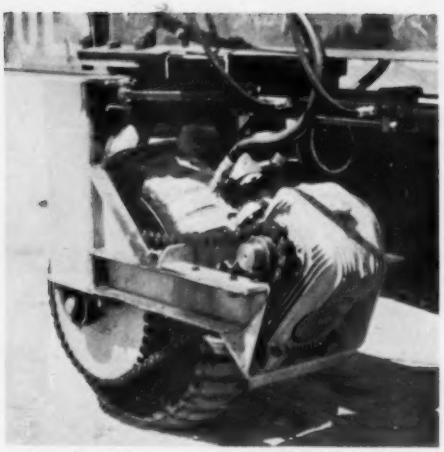
- Compactness. An air motor rated at .3 hp, for example, measures approximately 1 in. in diameter and 1½ in. long. Because it's small, it can be mounted within the tool.
- It can be operated up to the stall point without danger of burning out.
- Simple design. Gear reduction, for instance, is on the same axis as the motor.
- There are few maintenance and installation problems.

The Model 21K automation tool, operating on an inlet pressure of 90 lb/sq. in. has a 3-way valve. Air enters in two streams. One stream passes through the motor to produce rotary motion. The second stream is directed into the air cylinder where it pushes against a piston to produce linear motion. The air that's trapped when the piston reaches its predetermined stroke escapes through the third port of the valve so the piston can return. The piston is then retracted by a return spring.

Valving used to control tool operation is separate from the tool, allowing easy hookup to other components and machines. Valves and controls may be located wherever convenient. On many applications, all valving is mounted on a centrally-located control panel. Control signals can shut off the tool, start other tools, position the next part, or actuate any sequence of processes.

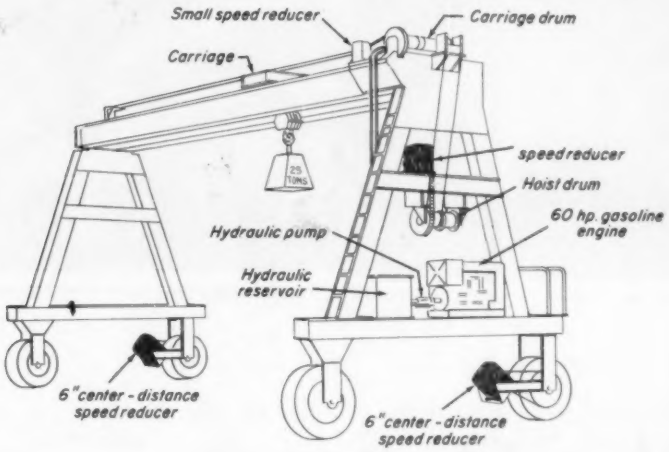
On certain jobs, it is desirable or even necessary that the tool continue to rotate while retracting. This can be done with a separate air line to the motor inlet, so that rotary motion continues during retraction. The separate air line may be controlled by its own 2-way valve for additional convenience, such as stopping the motor for cutting tool changes or stroke adjustment.

The length of stroke can be adjusted to micrometer accuracy by rotating a graduated external sleeve. This sleeve may be locked in any position. An integral needle valve can be adjusted to get desired feed rate, without affecting spindle speed. ▲▲▲



Hydraulic motor and speed reducer are bracket mounted, connected to front wheel by chain drive.

Crane has 25 ton capacity, loads 4 trucks at a time. Front wheels are steered by hydraulically-actuated link system.



Speed reducers in unusual crane drive

MOBILITY, added to the familiar bridge crane, frees it from restricted travel on tracks. Travelift & Engineering, Inc., Sturgeon Bay, Wis., mounted such a crane on four rubber-tired wheels and gave it a power source. A key factor in this successful design was the use of compact speed reducers.

In a typical 25-ton capacity model, a 60-hp gasoline engine provides the power for movement and control. The engine drives a hydraulic pump to operate hydraulic motors and cylinders. Front wheels are chain-driven by speed reducers, which are driven by hydraulic motors.

The front drive wheels also can be steered, giving the crane maneuverability which enables it to go wherever a big lift is needed, such as to loading areas for trucks. The crane is wide enough to service four trucks at a time.

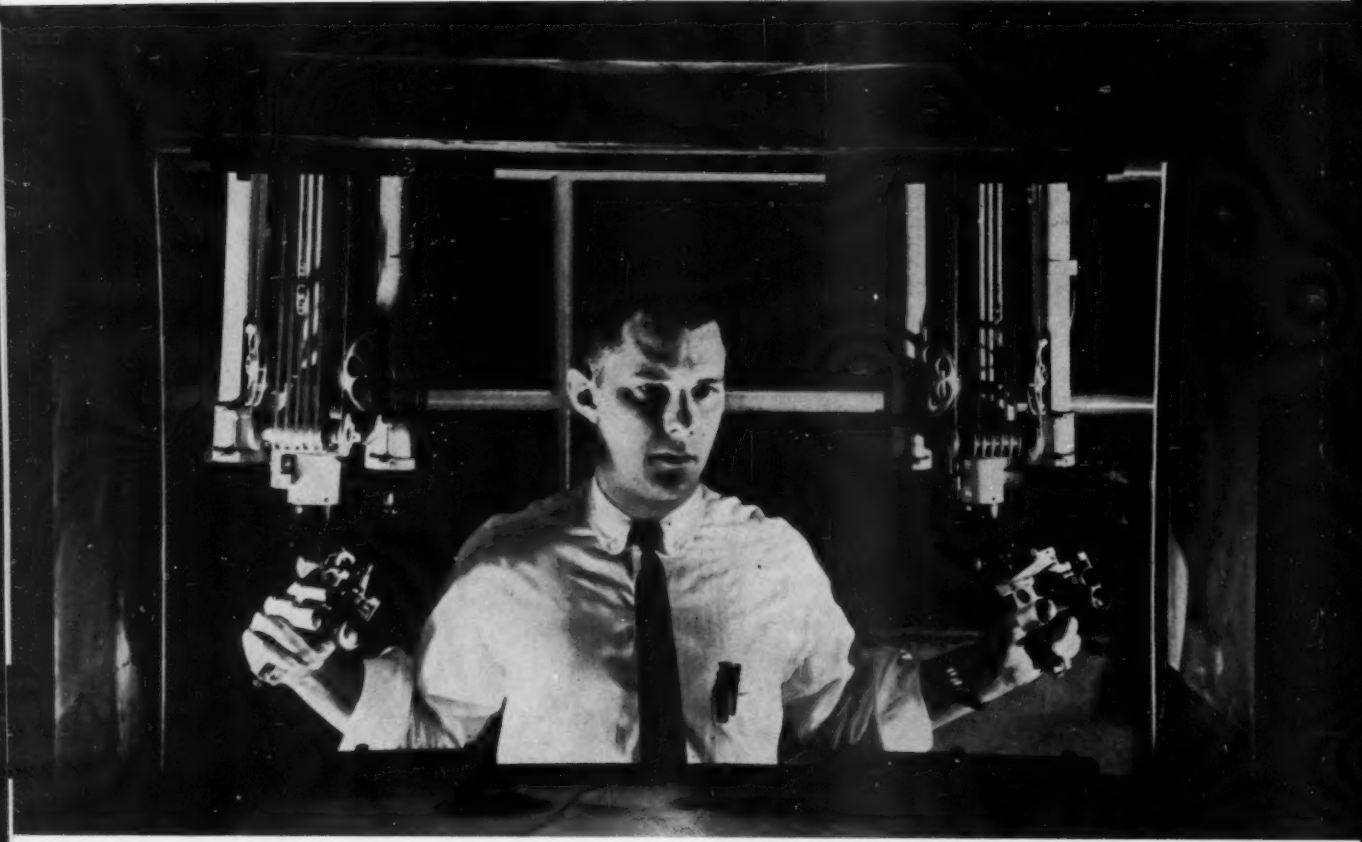
Motors and speed reducers are mounted on brackets attached to the wheel axle supports. In order to mount the reducers directly on the wheel brackets, it was necessary to select reducers that provided the necessary capacity yet took up minimum space.

Solution was a speed reducer with a 6-in. center distance. Its double-enveloping worm gear design gives high capacity combined with small size. Three of these reducers are used, plus a smaller one.

Input to either of the two wheel-drive speed reducers is from a reversible hydraulic motor flange-mounted on the reducer. The reducers are mounted at an angle to permit mounting the hydraulic motors close to the wheels and out of the way of possible damage in cramped working quarters. Wheels are steered by a system of links actuated by hydraulic cylinders.

Another 6-in. reducer is used to operate the hoist. A smaller motor-reducer combination moves the hoist carriage laterally across the bridge.

The control station and all hydraulic control valves are located on the right-hand side member of the crane over one of the drive wheels. The gasoline engine and hydraulic-fluid reservoir also are mounted there. ▲▲▲



Manipulator has a lifelike response to finger movements.

IDEAS
continued

Metal belts cut energy losses

A BELT-AND-PULLEY system with belts of high-cobalt *Nilcor* alloy strip helps manipulate radioactive materials with lifelike dexterity through thick protective walls. The strip, used in the *Master-Slave Manipulator* made by Central Research Laboratories, Inc., Red Wing, Minn., is produced by the Athenia Steel Div., National-Standard Co., Clifton, N. J.

. The *Nilcor* belts transfer motion and force so that the slave end in a nuclear hot cell duplicates motion of the master end, which is outside the cell, 10 ft away. In between is the shielding necessary to protect the operator from radioactivity.

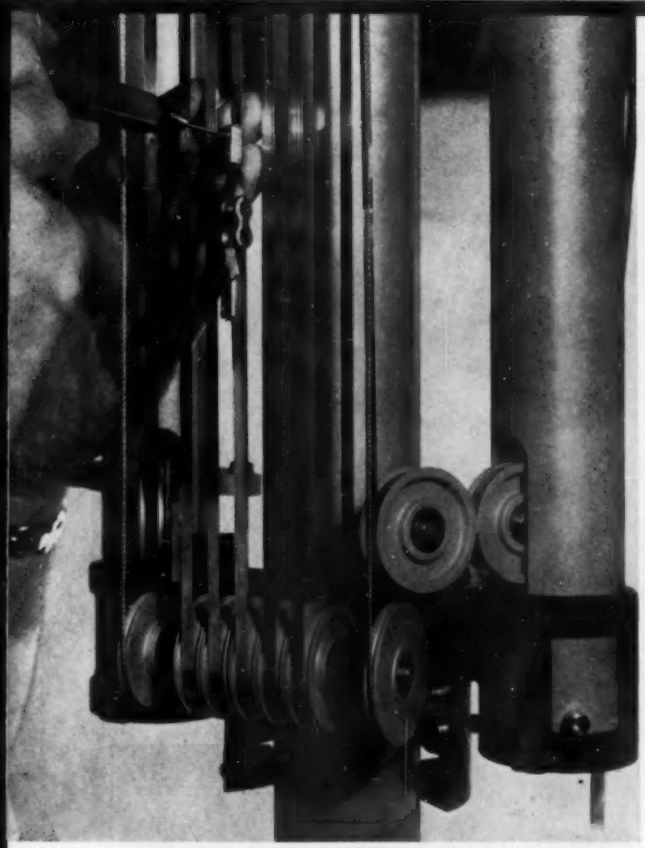
The belts are driven by the hands of the operator, working mechanical fingers inside the cell. The belts are not endless loops, but are seven individual strips that terminate at either end of the manipulator. They travel a reciprocating path of a few inches to a foot, each riding on from five to seven pulleys.

With such a complicated arrangement, a major design objective was to deliver as much useful force as possible from the master to the slave end, which would create an identical sense of touch at either end. This meant reducing energy losses due to friction, backlash, and overshoot, so that motion and force could be transferred as though there were no intervening mechanism.

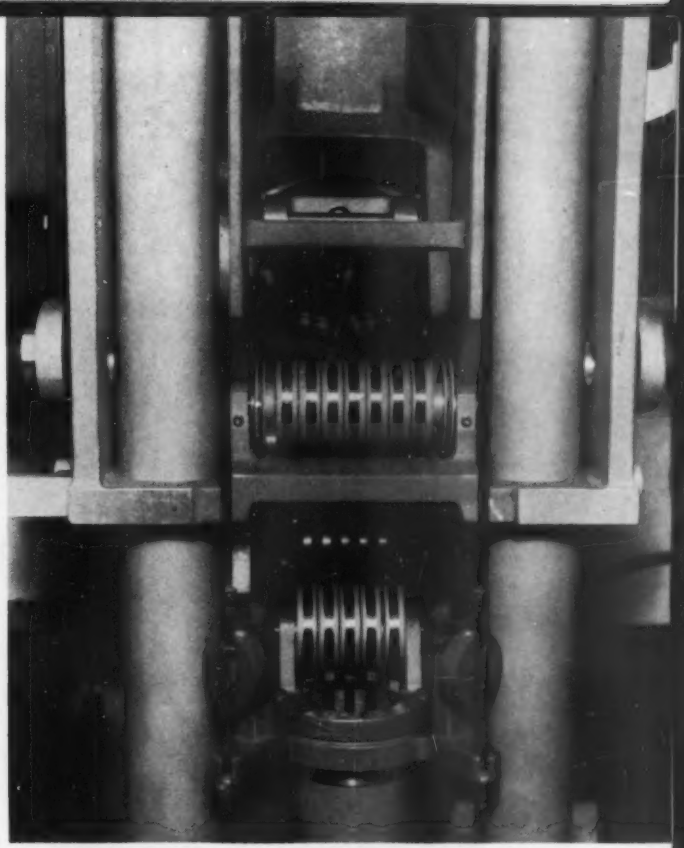
Such delicate response enables technicians to operate the manipulator without special training. And, because negligible energy is lost in the manipulator itself, payload at the slave end is limited only by the force applied at the master end.

The *Nilcor* strip reduces stretch in the manipulator by 80% and cuts friction by 90%, compared with the best stranded wire cable. Cable stretches four times more than the strip for several reasons. First, the lay of the strands tightens and loosens under load. Second, to get adequate flexibility, each strand would have to be so small that the stretch in each strand would add to lengthening of the lay.

There's little friction because the pulleys are crowned, with the strip making line-to-line contact. Stranded cable would make plane-to-plane contact. Also, the strip rides the center of each pulley, avoiding friction with pulley flanges. To further guard against friction with pulley flanges, the strip is fur-



High cobalt alloy strip cuts stretch 80% to eliminate backlash.

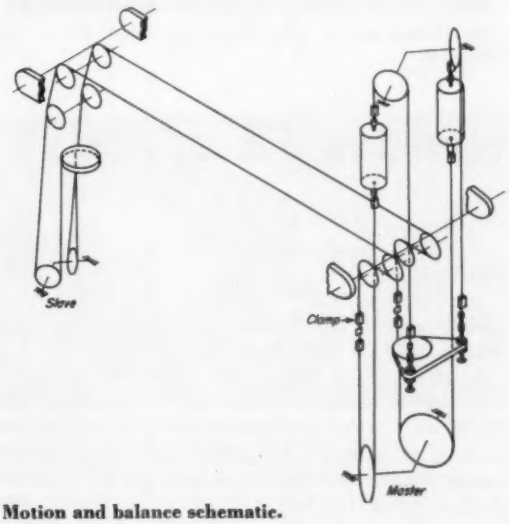


Strip rides center of pulley, so there's no friction with pulley flanges.

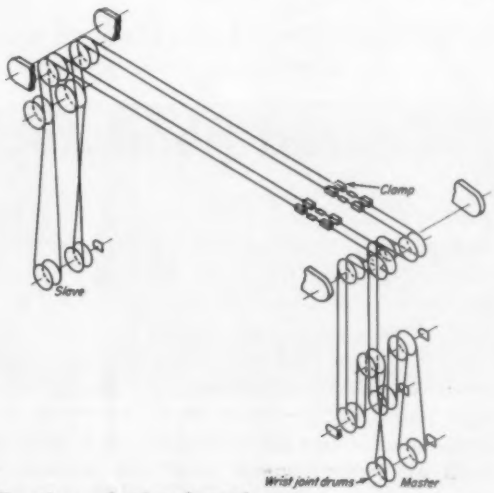
nished with less than ½ in. lateral sweep in an 8 ft length resting flat without tension.

Nilcor strip works well because of its high fatigue resistance, high tensile strength, and good corrosion resistance. Other factors in its favor are that it is unaffected by 500-hour exposure to salt spray, it is unaffected by finger prints and humidity, it is nonmagnetic, and it is highly resistant to acids. Its composition is 40% cobalt, 20% chromium, 15% nickel, 7% molybdenum, 2% manganese, .15% carbon, .04% beryllium, and the balance iron.

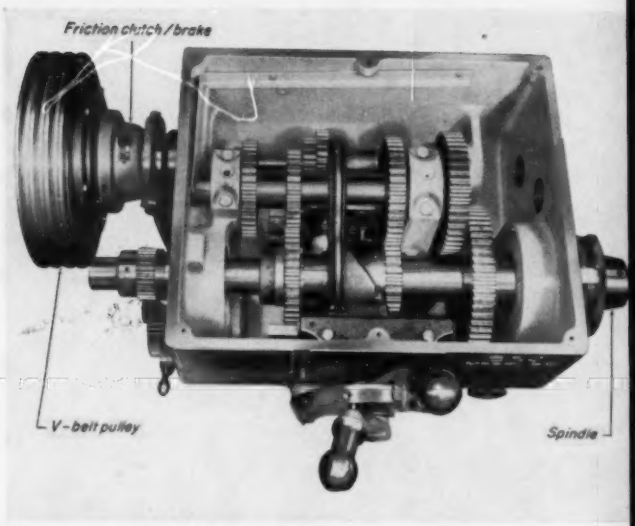
To get flexibility with small pulleys and still keep stress well below yield, .005 in. strip is used. It's .185 in. wide and is furnished in 200-ft coils. Stress on the strip under steady full load is 20% of yield. Under impact loads, stress may go to 25% of yield. ▲▲▲



Motion and balance schematic.



Elevation and twist schematic.



Above: geared headstock assembly.

Left: motor drive arrangement shows convenient mounting of motor in cabinet leg with multiple V-belt drive to headstock V-pulley.

Two shifter handes give quick convenient spindle speed changes.

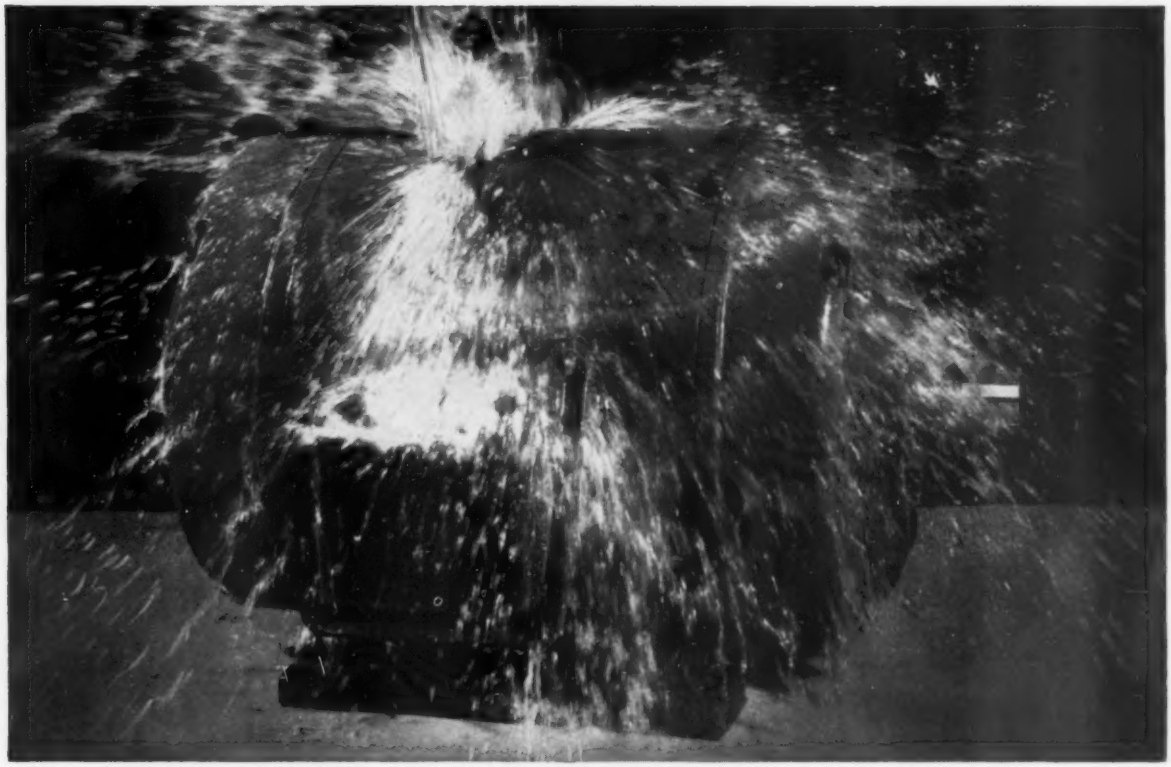
Geared headstock provides 12 speeds

TWO SPEED-CHANGE levers on an all-geared headstock provide 12-spindle speeds for the *C & J Master Model* lathe manufactured by the Carroll-Jamieson Machine Tool Co., Batavia, Ohio.

Its all-geared headstock is said to provide convenience, power, and durability. You get spindle speeds from 20 to 900 rpm by combining any of three ranges on one speed-change lever with four on the other. Gears are heat-treated alloy steel, and shafts are ground special steel. The headstock is lubricated by a splash system, with all parts running in a constant oil bath.

The taper nose spindle is mounted in precision taper roller bearings. At 100 rpm, the front spindle bearing takes a 6622 lb radial load, and 5227 lb thrust load. The rear spindle bearing takes a radial load of 5681 lb, and a thrust load of 3776 lb.

A 5-hp motor powers the headstock through a triple V-belt pulley on the drive shaft. A friction clutch and brake provide spindle control without starting or stopping the motor. An apron control handle permits spindle control from the apron at any position along the bed. ▲▲▲



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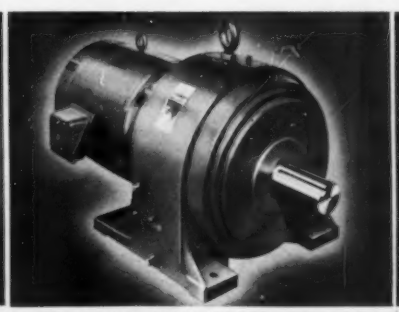
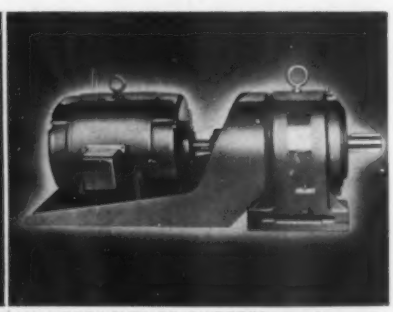
SLEEVE BEARING MODELS AVAILABLE . . . DP Motors are built in NEMA frame sizes 182 through 445U; 1 through 125 hp—1750 RPM—40°C; available with ball bearing construction as illustrated or steel-backed, babbitt-lined sleeve bearings. Larger motors (Type RP) are available through 1000 hp.



INTEGRAL TYPE GEARMOTORS powered by Wagner DP Motors are available. These single, compact units combine Wagner motor dependability with foot mounted or flange mounted gear units to give you single, double, triple, or quadruple speed reduction.



ALL-MOTOR TYPE GEARMOTORS are also available with Wagner DP Motors. Like all Wagner Gearmotors, they have "high hardness" gears that provide greater power transmission, longer wear life, greater resistance to shock. For complete information, write for Bulletin MU-237.

WM60-20A

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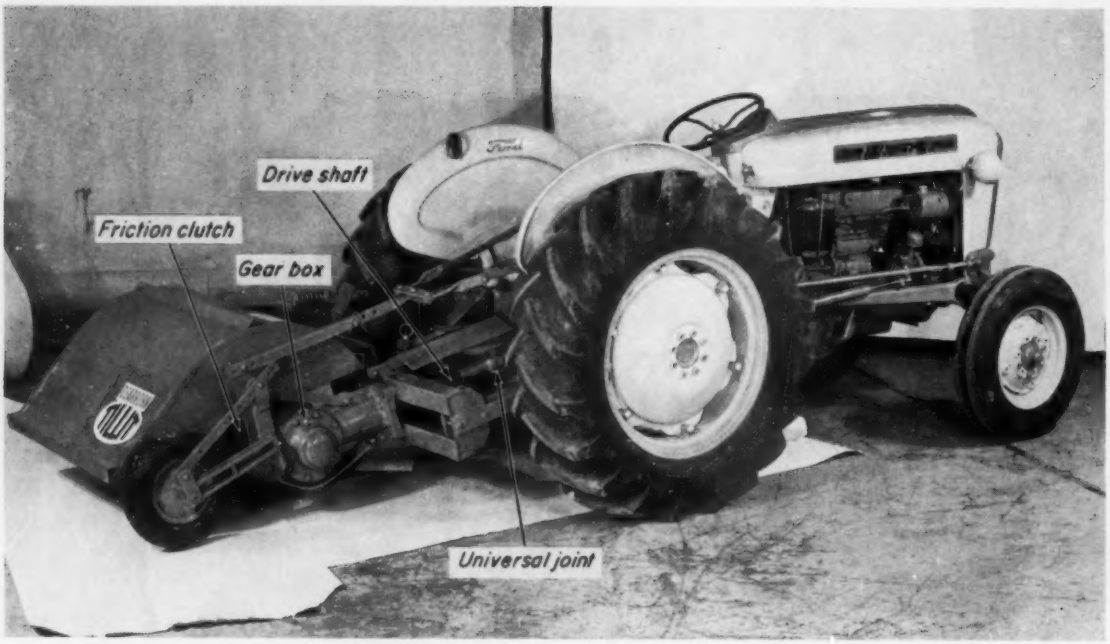


The offset Dearborn Tillit, for use to the left or right of the tractor, delivers a constant rotor speed. It employs PTO drive from the tractor spline to a right angle gear box, whose shaft serves as the mounting axle for the tines.

IDEAS
continued

Tiller drive combines power, safety

THE DRIVE SYSTEM of a rotary tiller must be able to transmit plenty of power for heavy-duty work, yet provide overload protection if it should hit a rock or other obstacle.

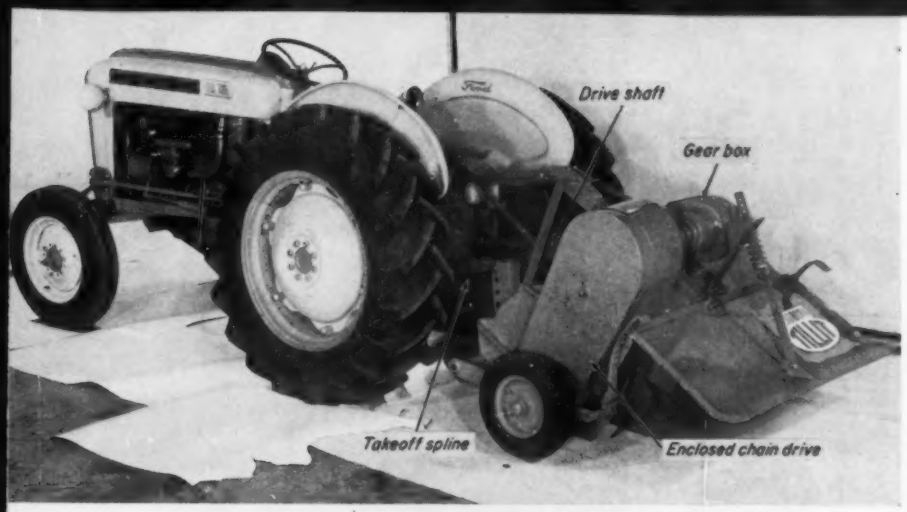
A tiller that does both is the *Dearborn Tillit*, developed by American-Marietta Corp., Milwaukee, and marketed by Ford Motor Co.'s Tractor and Implement Div. Hitched to a tractor it can churn hard dirt into a smooth, homogenous layer for road building, lawn renovation, compost mixing, or other soil preparing jobs.

Driven by the tractor's power takeoff, the *Tillit* digs as deep as 6 in. into the ground with from 30 to 48 rotating tines. It can be used with any tractor having the proper three-point implement linkage system.

Made in five models, its cutting width ranges from 36 to 60 in., with either a centered or offset hitch. All models have the same basic design, with the power train capable of handling up to 80 input hp. The drive shaft from tractor takeoff to tiller has standard $1\frac{3}{8}$ in. heavy-duty universal joints. The one-piece rotor shaft on which the tines are mounted is supported by sealed ball bearings in self-aligning mountings to withstand the heavy shocks of rotary tiller operation. Two anti-wrap plates protect the bearings from vine, weed, or wire wrapping.

A torque-limiting friction clutch prevents damage in case the tiller runs into an obstacle. Clutch springs are adjusted to provide enough tension on the clutch facings for tilling, but if the rotor becomes overloaded, the clutch will slip. When the overload is removed, the clutch again transmits power.

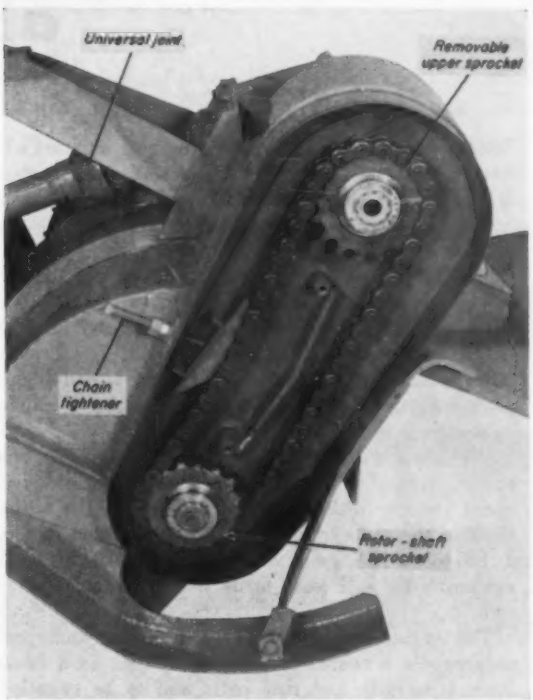
One model, the 36-in. size, is offset either to the right or left of the tractor. Its drive system is different from the other models, and it's attached with a special offset hitch. Power from the takeoff travels straight through the drive shaft to a right-angle gear box. Output from the gear box drives the rotor shaft through the clutch at constant speed.



Center-mounted Dearborn Tillit has gearbox on top the implement. A shaft extends to the upper gear on a side mounted chain drive.

Left: Torque limiting friction clutch protects tool from damage if tines hit rocks.

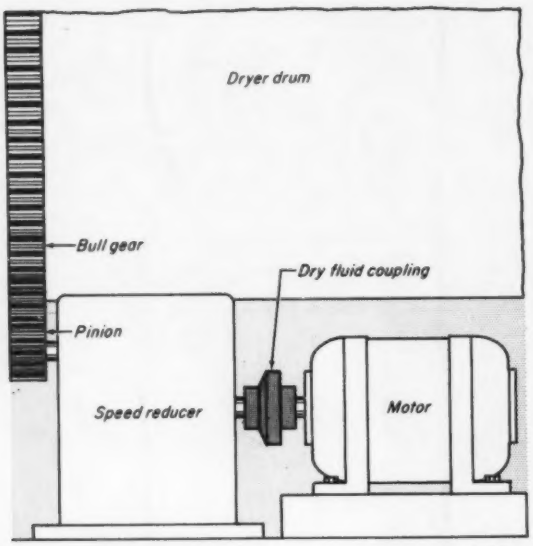
Bottom: Changing chain drive's upper sprocket changes tine speeds to suit soil conditions.



The four larger models—48 and 60-in. widths—are attached with a standard three-point hitch. The takeoff drives to a right-angle gear box mounted on top of the tiller. A shaft extends from the gear box, through the friction clutch, to the upper sprocket on a side-mounted chain drive. The chain drive's lower sprocket then drives the rotor shaft.

Tine speeds can be adjusted to suit most soil and job conditions by changing the upper sprocket on the chain drive. With a takeoff speed of 550 rpm, the standard 17-tooth sprocket drives the rotor at 175 rpm. By substituting a 13-tooth sprocket, you get a slow rotor speed of 135 rpm. A 24-tooth sprocket delivers 250 rpm. Slow speeds leave coarse clods, fast speeds give finely-mixed soil.

The roller-chain drive operates in a sealed housing containing gear oil. When changing sprockets, the housing cover can be opened easily by removing two bolts. To compensate for normal chain wear, a chain tightener can be adjusted from outside the chain case. ▲▲▲



Power to rotate big dryer drum in fertilizer plant is transmitted from 75 hp motor through a dry fluid drive (centrifugal clutch) and base mounted speed reducer.

Dry-fluid coupling absorbs shock loads

HEAVY-LOAD starts, stops, and jogging imposed such severe strain on the power transmission components in a large drum-type dryer that couplings had to be repaired as often as twice a week. The problem was eliminated by installing a dry-fluid coupling.

The dryer operates 24 hours a day, 7 days a week, in a fertilizer plant, where it processes about 40 tons of fertilizer pellets an hour. The dryer is stopped once a day for cleaning and other servicing. This means it has to be stopped, started, and jogged frequently during the shutdown, subjecting the drive system to severe shock loads.

The system is powered by a 75 hp, 1770 rpm motor, through a coupling, and into a parallel-shaft speed reducer with 45.1:1 reduction. On the output shaft of the reducer there's a 21-tooth pinion driving a 195-tooth bull gear which is about 13 ft in diameter. This bull gear turns the dryer at about 4 rpm.

The original coupling between the motor and speed reducer was a source of constant trouble, as it broke down frequently and new parts had to be installed.

This coupling was replaced with a 15-in. dry-fluid coupling which serves as a centrifugal clutch to pick up the heavy load of the rotary dryer without undue strain on the motor. It is designed to slip under shock loads or overloads to protect the motor and driven equipment.

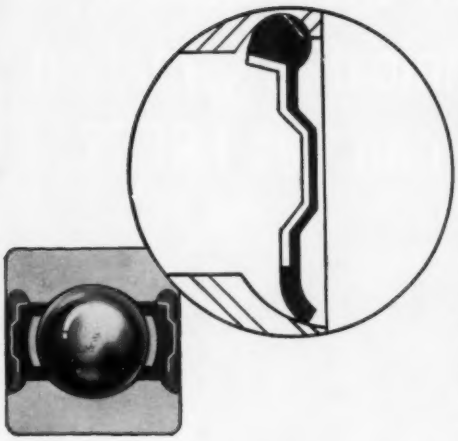
Dry fluid in the coupling is about 15 lb of heat-treated steel shot, called the flow charge, and is contained in the housing. When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and a rotor which transmits power to the load.

After the starting period of slippage between housing and rotor, the two lock together and accelerate to full load speed, operating without slip.

In the two years the coupling has been in service, the only maintenance required was to replace the flow charge after about 1½ years of continuous operation. Not only has this coupling eliminated downtime to replace parts, but it provides smoother acceleration and better control of the big drum during jogging and reversing cycles. ▲▲▲

IN *Sealed* BALL BEARINGS

MARLIN-ROCKWELL RELIABILITY COUNTS



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- reduces maintenance time
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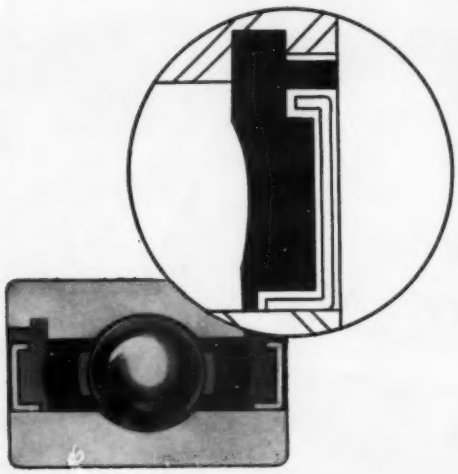
- best seal for AFBMA standard single-row width bearings



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- best seal available for cartridge width bearings

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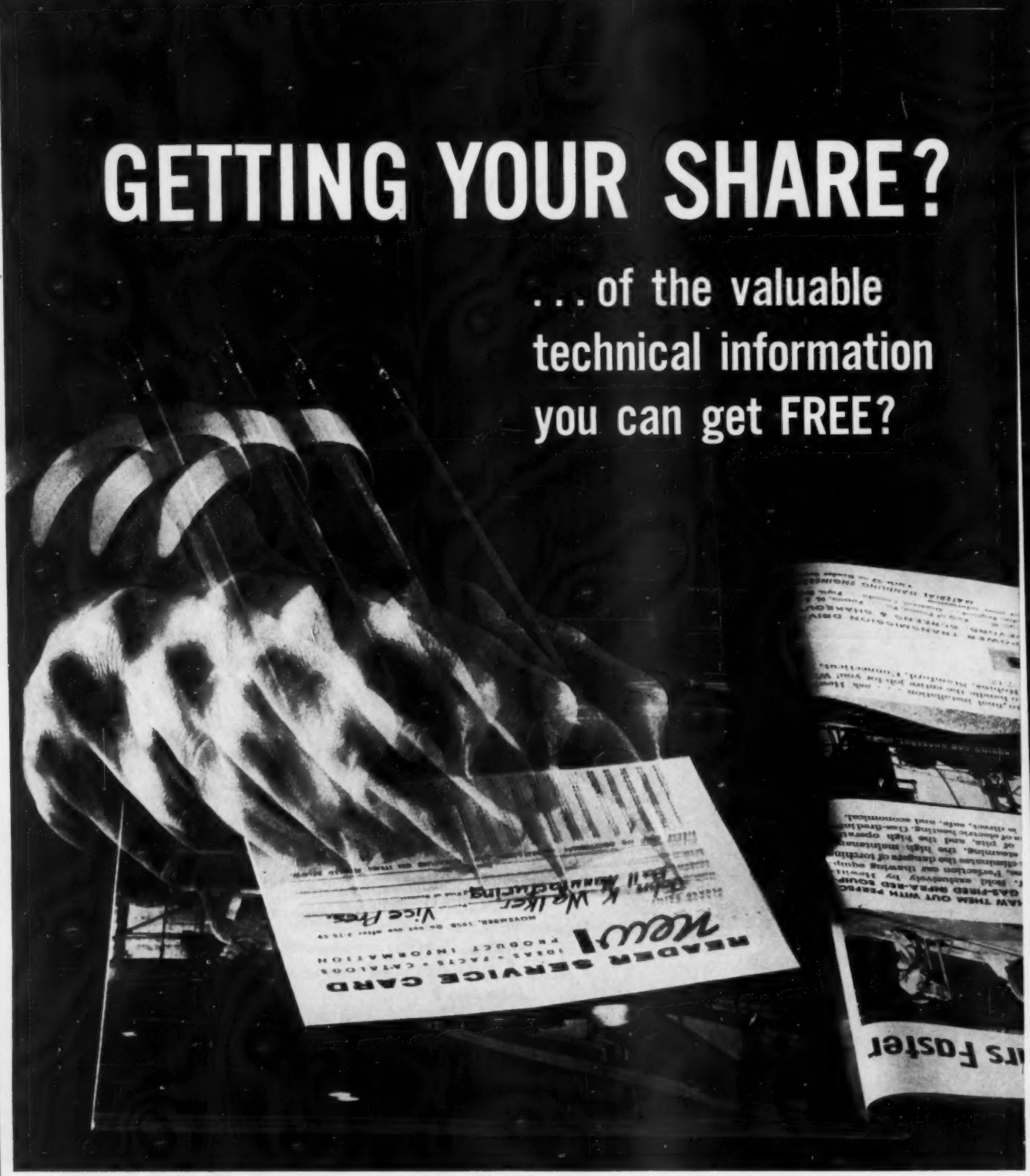

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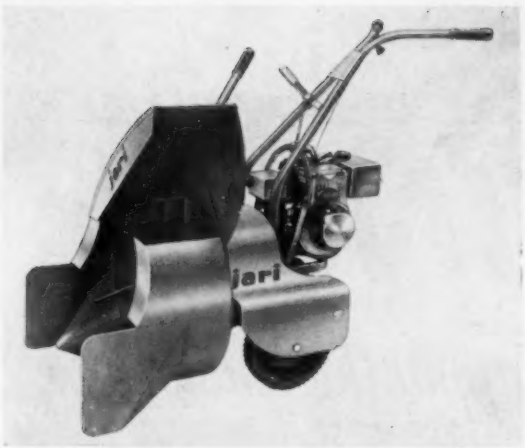
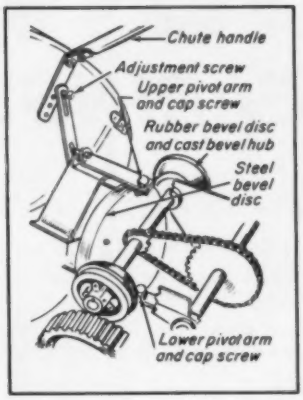
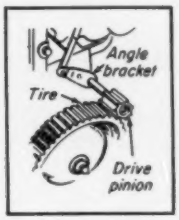



Chute handle
Adjustment screw
Upper pivot arm and cap screw
Rubber bevel disc and cast bevel hub
Steel bevel disc
Lower pivot arm and cap screw

Top left, machine throwing snow to right, arrow shows fan turning right. Above, throwing to left, fan turns left.

Sketch shows how steel bevel disc makes contact with either left or right rubber disc to rotate in either direction.

IDEAS *continued*



Bevel disks reverse fan on 2-way snowthrower

A SELF-PROPELLED sidewalk-driveway snowthrower has a rotary fan that changes direction at the same time the discharge chute is reversed. Called the *Jari 2-Way Snowthrower,* it's made by Jari Products, Inc., Minneapolis.

Because both fan and chute can be reversed simultaneously, the *2-Way* is equally efficient whether throwing snow to the right or left. This is an advantage when clearing snow along buildings and driveways, or when you want to throw snow with the wind to prevent blowback.

Powered by a 3 hp engine, the *2-Way* clears a 20-in. path and can remove 520 shovelsful of snow a minute. Snow can be thrown up to 30 ft to prevent formation of high banks. Double-flared fan blades remove snow completely, regardless of fan direction.

Power for the primary drive is transmitted by a V-belt from the engine shaft to a countershaft. The V-belt is tensioned automatically and requires no tightening. There's a rubber bevel disk at either end of the countershaft. These disks are pivoted to the right or left against a central steel bevel disk to transmit power to the rotary snowthrower fan and turn it in either direction.

Direction of the fan is reversed automatically when the position of the discharge chute is changed by moving a control handle. When the handle is moved to either side, the chute engages in a catch. The entire tractor unit pivots slightly to permit one of the rubber disks to engage with the steel disk, rotating the fan in the direction the chute is aimed.

When the chute handle is centered, there's about 1/16 in. clearance between the rubber disks and the central disk, so neither disk is engaged and the fan doesn't rotate. The snowthrower portion of the machine is bolted to the tractor unit by an upper and lower pivot arm to permit the pivoting action and simultaneous reversing of the fan and chute.

The wheel drive takes off from the middle of the countershaft through a chain-and-sprocket assembly. Pinions at either end of the power unit shaft engage with two 10-in. rubber cogged tires to propel the machine when the forward drive is engaged. These cog wheels provide positive traction for scraping pavements clean. A 2-in. skid can be attached for clearing gravel and other rough surfaces. A raker bar on the fan and the open chute enable it to handle any type of snow without clogging.

A carburetor cover extends over the muffler to keep the carburetor warm and snow-free. A one-piece contoured fender covers the wheels, drive, and internal working parts. The machine measures 23½ in. from wheel axle forward, and it weighs 145 lb. ▲▲▲

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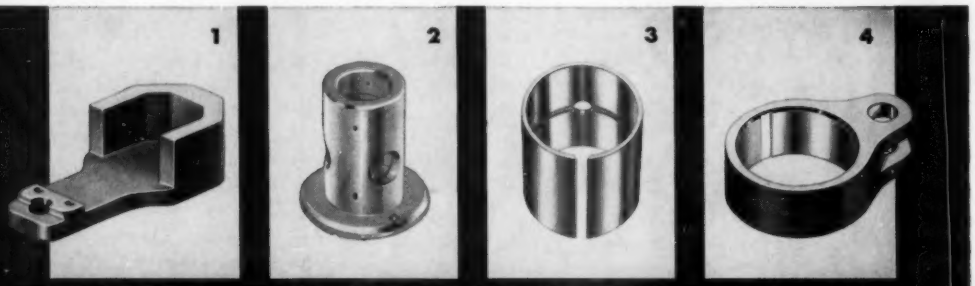

1 The great and diverse cost advantages of powder metallurgy are revealed in the highly complex nature of this bearing support plate for power tools made in Bunting's Powdered Sintered Metals Plant.

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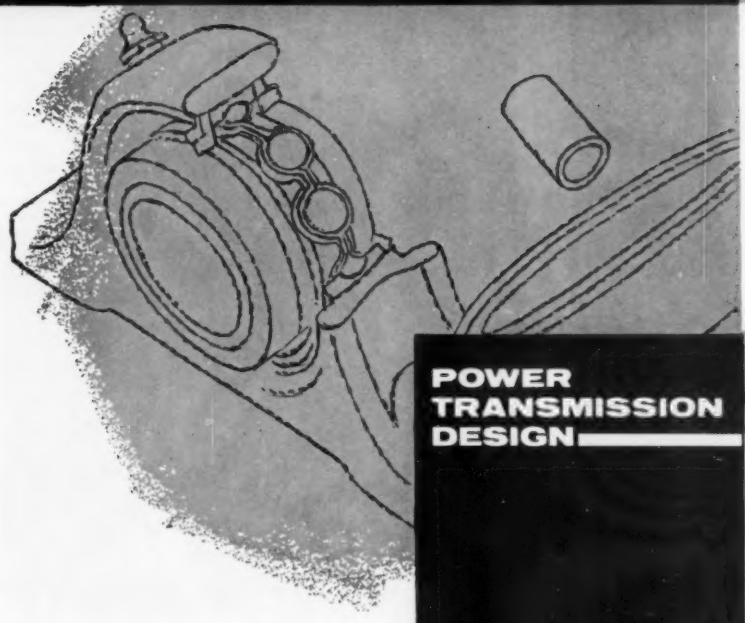
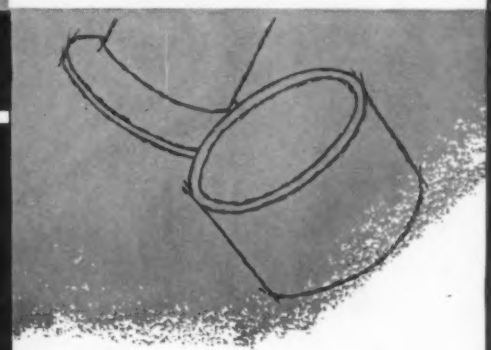
BEARINGS

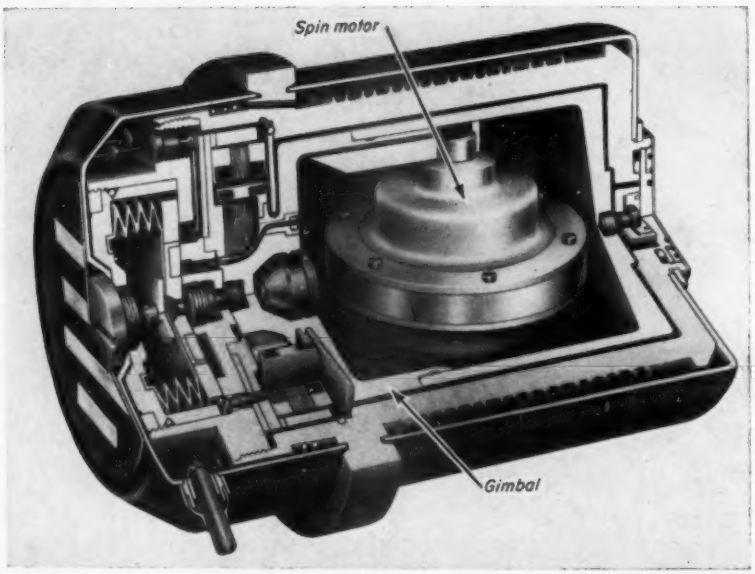
DESIGN/APPLICATION



REGULAR MONTHLY SECTION OF IDEAS AND DEVELOPMENTS

POWER TRANSMISSION DESIGN

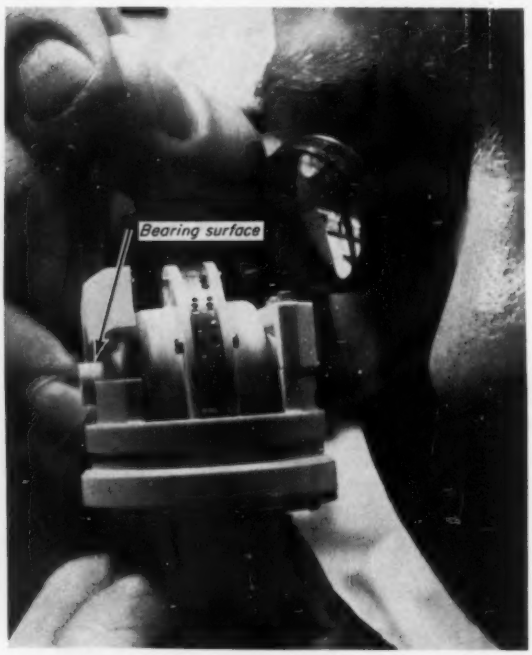




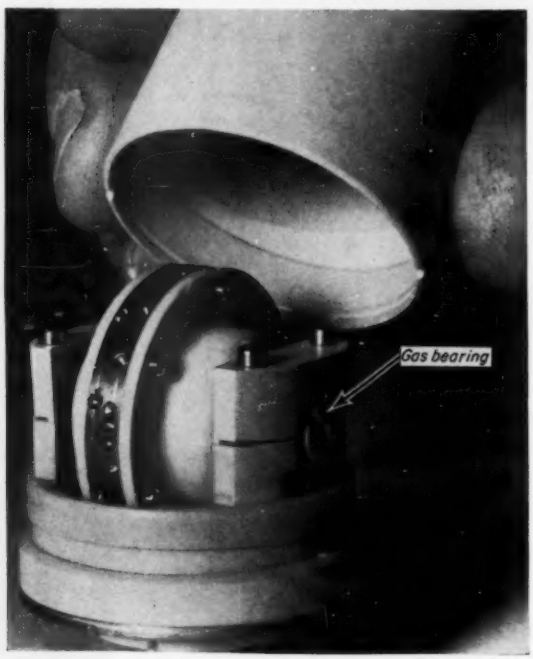
Sapphire-hard ceramic is used for gimbal, coil cup and spin motor stator encapsulation, as well as bearings. Spin motor turns at 24,000 rpm.

Tough, stable ceramic bearings give gyro high accuracy

Bearing surface is ground and honed with diamond compounds. Drilled balance wheel is only metal part.



Spin motor shaft is supported on helium film 25 millionths of an inch thick. Total assembly weighs 8 oz.



MINIATURE CERAMIC BEARINGS have virtually eliminated drift inaccuracies in the first ceramic gyroscope, developed for the aerospace industry by the Aeronautical Div., Minneapolis-Honeywell Regulator Co.

This is no small feat, when you consider the problems arising from the very nature of a gyro's operation. One of the most troublesome is that of unwanted torques. For example, friction torque limits a gyro's angular rate threshold capability. Since the new gyro is a floated type, its spin motor is sealed in a cylindrical gimbal supported by a viscous fluid. This practically eliminates friction torque.

Then there are unbalance torques. These may come from gimbal unbalance, electromagnetic reaction of pickoffs and torque generators, elastic restraint of the flex leads supplying power for the spin motor, or from the complex responses of the gyro under vibration inputs. Certain unbalance torques are consistent and repeatable, like magnetic restraint and flex lead elastic restraint. These fixed errors can be balanced out by trim adjustment.

However, other unbalance torques can't be compensated because they are inconsistent. For instance, the unbalance torques at the rotating spin-motor shaft are largely responsible for drift errors. These torques result from movement of shaft-supporting elements, mechanical hysteresis effects due to material damping and slippage, stress under angular motion which causes deformations that change the balance of the gyro, and mechanical rectification of vibrations.

Ceramic gas bearings have proved highly effective in controlling these unwanted torques, giving the gyro a high performance rating. The bearings, used to support the ends of the spin-motor shaft, are lubricated by a film of gas only 25 millionths of an inch thick. The film of gas, while virtually friction free, is under self-generated pressure. Vibration and noise are greatly reduced. Viscous damping is substituted for hysteresis damping, and there is no deformation due to thermal expansion.

Gas, such as air or helium, is an effective bearing lubricant so long as the bearing geometry is right. Since the elements of the gas-lubricated bearing are separated by a thin film of gas while operating, there is no contact of the elements, and wear is negligible. However, careful choice of material is necessary to provide high reliability for a number of starts and stops. Important factors include surface finish, cleanability, hardness, and stability over time and temperature cycling.

The ceramic material developed by Honeywell is as hard as sapphire. In tests, the ceramic bearings have undergone thousands of starts and stops without detectible wear. The material has a high modulus of elasticity and exhibits low long-term creep. In stability tests, when subjected to temperatures ranging from —85 F to 1500 F, it retained its original dimensions within 2 millionths of an inch.

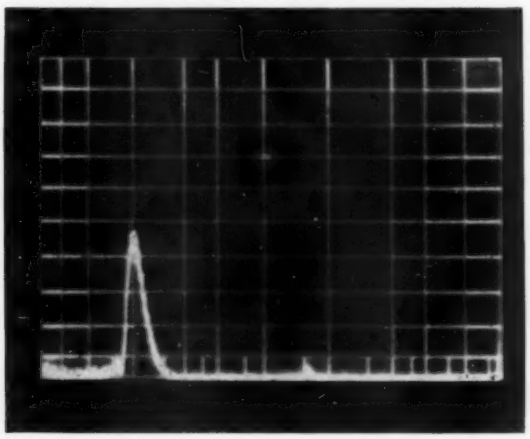
Because of its stability advantages, the ceramic material is used for other parts of the gyro, including the gimbal, coil cup, and encapsulation of the spin-motor stator.

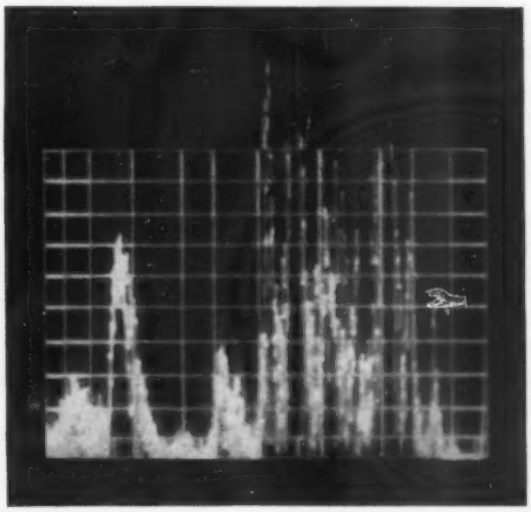
The parts are rough-cast in powdered form. The material can be worked easily in the half-fired "green" state. After final firing at 3200 F, the ceramic becomes harder than ordinary grinding wheel materials. It is ground and honed with diamond compounds to extreme accuracy and excellent surface finish. Tolerances on some parts are held to less than 3 millionths of an inch.

Contamination, always a problem in floated gyros, is even more critical with the extremely small clearances in the gas bearings. In fact, 1-micron dust particles can't be tolerated. Another advantage of using ceramic parts is that they can be cleaned with hydrochloric acid, which dissolves everything but the ceramic.

The gyro is 2.817 in. long, 2.0 in. in diameter. ▲▲▲

Oscilloscope traces show superiority of viscous damping over hysteresis damping. Gas bearing trace at left





Mr. R. A. Weaver, Electrical Superintendent, Dole Hawaiian Pineapple Company states: **"On the basis of evaluation and comparison with other drives . . . We found General Electric Polydyne® Drives best meet our adjustable-speed requirements."**

At Dole Hawaiian Pineapple Company's Honolulu Cannery, "Ginaca" processing machines can automatically reduce whole pineapples into separate "components" of core, rind, pulp and a cylinder ready for final processing at a rate of up to 6000 per hour. With a constant-speed motor drive it is necessary to stop and start a Ginaca to control output. However, the Polydyne Drive can match the varying conditions at each stage of the processing system. The adaptability of Polydyne Drives reduces the need for supervisory attention and permits maximum processing efficiency.

Dole Company personnel selected General Electric's Polydyne Drives for the quick and smooth response to speed adjustments demanded by their continuous processing system. As Mr. Weaver also commented, "In our evaluations and comparisons with other drives we gave particular attention to ease of belt replacement because this makes maintenance simple and reduces downtime. We found Polydyne Drives far superior to other drives for making belt changes quickly."

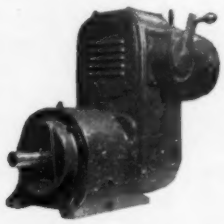
When your application requires low-cost adjustable speed combined with reliability and ease of maintenance, investigate G-E Polydyne Drives. Your General Electric Sales Engineer has full details. Or, write for bulletin GEA-6806, Section 854-05, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

Circle No. 16 on Reader Service Card

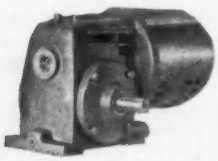
GENERAL ELECTRIC OFFERS A *COMPLETE* LINE OF LOW-SPEED DRIVES 1/8 TO 200 HP

Select from G.E.'s PLUS LINE of compact mechanical power transmission equipment! A full range of ratings is available—many directly from stock.

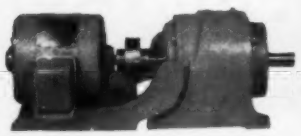


General Electric Polydyne Drive

Integral-type Gear Motor

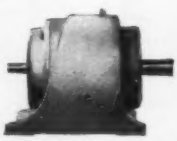


Right-angle Shaft Gear Motor



All-motor Gear Motor

Footed Speed Reducer



Shaft-mounted Speed Reducer

Member of
American Gear Manufacturers' Association

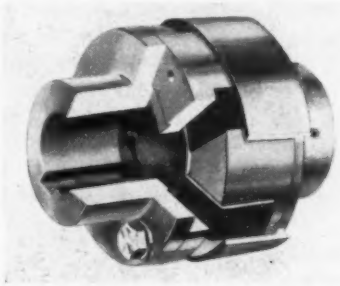
GENERAL ELECTRIC

NEW PRODUCTS

To get complete information on these products, use the Reader Service Cards bound into this issue.

Quick-disconnect flexible couplings

Standard duty Type CQ and heavy duty Type HQ have one set of jaws in removable ring form. Pulling the jaw ring outward provides enough



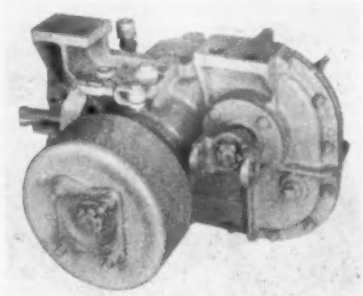
clearance for independent rotation of either end of the coupling. By reversing a set of cap screws from one body to the other, connected machinery can be removed radially without disturbing the power transmitting elements. Maximum bores for Type CQ from 1⅜ in. to 5½ in.; from 2.58 hp to 156 hp at 100 rpm. Type HQ max. bores from 1¾ in. to 8½ in., hp from 7.77 to 810 at 100 rpm.

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle No. 200 on Reader Service Card

Split-shaft power take-off

Model TML, an improved version of Model TM, is for use where short wheelbase chassis create problems with drive line angle and ground clearance. Capable of delivering



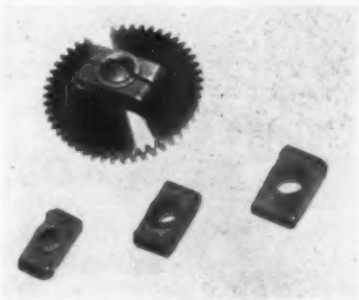
torque loads to 6100 lb-ft, it has a shorter gear case than most full torque PTO's, so there's sufficient ground clearance for trucks that must travel off the highways. The 3-point mounting system permits the PTO to move with the frame. Ratios of 71, 88, 104 and 129 percent of input are available with right-hand output shafts forward, rear, or both. Output shafts have counter-engine-wise rotation. The Electro-Matic shift, with an electric cable replacing mechanical linkages, is easy to work and especially convenient for tilt-cab chassis. A variety of optional accessories includes Bendix brakes and a special drive shaft with a slip spline.

Waterous Co., St. Paul, Minn.

Circle No. 201 on Reader Service Card

Adjustable hub clamps

Dynamically balanced for use with high speed precision motors, synchros, resolvers and instrument shafts, this improved line of clamps



is available from stock in ⅛, 3/16 and ¼ in. shaft sizes. Conforming to MIL specifications, clamps are made from heat treated #416 stainless steel.

PIC Design Corp., East Rockaway, N. Y.

Circle No. 202 on Reader Service Card

Redesigned hollow shaft motor

Most recent models in a redesign of a vertical hollow shaft motor line are of open drip-proof, high-thrust construction in frame sizes 364UP to 445UP, inclusive. New features include a removeable aluminum top

cover for rapid adjustment of pump clearances and a shaft locking bar to stop movements of the motor's rotating parts while the impeller is being adjusted. Upper and lower bearings are oil lubricated. Self release couplings are standard equipment, but a pin-type non-reversing ratchet is available where motor backspin is undesirable. Double end ventilation gives a cooler running motor, with Poxeal insulation for severe environment. Addition of this series completes a rerating program on the 182 to 445U frames.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Circle No. 203 on Reader Service Card

Variable torque limiter

The latest of four torque-limiting devices, the Torque-Master XB-150 can be adjusted manually to slip at any setting from 10 lb-ft to 150 lb-ft, or can be locked in positive drive. It acts as an automatic shear-pin mechanism, slipping only when a jam-up occurs and re-engaging when overload is relieved. Torque output remains constant when exposed to changing temperatures, oil or abrasives. Reversible hardened steel wear plate doubles plate life. Bushings are

interchangeable, from 1/2 in. to 1 7/16 in. bores. No machining required to fit single, double or triple groove sheaves and sprockets.

Torque-Master Div of Roberts Aircraft Engine Co., Burbank, Calif.

Circle No. 204 on Reader Service Card

Vibration meter

Called the Autotrack analyser, it is capable of detecting the exact source of vibration in an assembled jet engine by "listening" to the exact frequency of a particular component. It can detect the difference between two separate vibrations just 1 cps apart, provided one signal is larger than the other. Even if the signal volumes are identical, a 2 cps difference in frequencies can be detected. The instrument tracks frequencies at every engine speed once it is tuned to a particular shaft or component. Frequency range is 5 to 2,500 cps. An input signal from a standard velocity type vibration pickup (microphone, accelerometer or pressure transducer) is in effect compared with the signal from the engine tachometer or an exact multiple of it. This reference frequency is mixed with the output of a 100 KC crystal oscillator and the combined frequency mixed with the input signal. If this contains any components equal to the reference signal, a portion of the combined signal will be cancelled, restoring the 100 KC frequency by an equivalent amount. A filter removes all but the 100 KC component, which is a direct measure of the amount of vibration in the input signal, at reference frequency.

Convair Div., General Dynamics Corp., San Diego, Calif.

Circle No. 205 on Reader Service Card

Industry's NEWEST Production TOOL

MOLYKOTE® G LUBRICANT

- ALMOST 100% SAFETY AGAINST GALLING AND SEIZING WITH ALL BEARING METAL COMBINATIONS
- ELIMINATES STICK-SLIP, METAL PICK-UP AND DISTORTION IN PRESS FITTING
- REDUCES WEAR-IN TIME AND DAMAGE IN NEW OR REBUILT MACHINERY
- THE HIGHER THE LOADS, THE GREATER THE MARGIN OF SUPERIORITY OF MOLYKOTE G

Write for your free sample of MOLYKOTE G LUBRICANT today. We will also send you a copy of our new Bulletin 126 which gives complete details. THE ALPHA-MOLYKOTE CORPORATION, 65 Harvard Avenue, Stamford, Conn. Phone Fireside 8-3724. Plants in Stamford, Conn., Munich, Germany and Strasbourg, France.

PTD-12

THE ALPHA-MOLYKOTE CORP.
65 Harvard Ave., Stamford, Conn.
Please send me a free sample of your MOLYKOTE G Lubricant.

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CITY_____ ZONE____ STATE_____

Circle No. 3 on Reader Service Card

specify **PRECISION UNIVERSAL JOINTS**

1st choice for dependable power transmission!

Power take-off at an angle required? Precision Universal Joints are preferred because of exclusive design features: manufactured of aircraft steel, uniformly hardened and machined to precise tolerances. Same size parts are interchangeable. Available blank, bored, broached, threaded, cross drilled or tapped according to your exact specifications!

Need more information?

Clip this ad and attach to your letterhead for FREE folder. PTD-120

PRECISION TOOL & MFG. CO. of Illinois

1305 S. LARAMIE AVENUE / CICERO 50, ILL.

Circle No. 20 on Reader Service Card

Infinitely variable-speed drive

The new Vari-Gear Drive provides infinitely variable output speeds in each of 4 different transmission ratios. With an 1800 rpm motor you can get every rpm between 180 and 1800, with a 1200 rpm motor every rpm between 120 and 1200.

Furnished in dripproof or totally enclosed fan-cooled construction, at ½, ¾ or 1 hp. The four speed transmission is said to result in three times greater torque at low speed than any comparable friction type unit. A control wheel regulates the output shaft to the desired rpm. Exact rpm of the output shaft is shown by a pointer on a calibrated speed plate.

Lima Electric Motor Co., Inc., Lima, Ohio.

Circle No. 206 on Reader Service Card

Lubricant level indicator

Main components of this indicator, which can be used for a variety of liquids as well as lubricants, are an electronic control and a sensing element combined as a single unit. It

does not depend on capacitance or capacitors and will operate reliably under severe vibration and high temperatures. Response time is adjustable. The indicator remains off until liquid level drops to a predetermined point when it flashes or sounds a warning. A special design feature prevents false readings if the sensing element is briefly uncovered. The circuit can be checked at any time with a press-to-test button.

Electronics Dept., Hamilton Standard, Broad Brook, Conn.

Circle No. 207 on Reader Service Card

Isometric gear guide

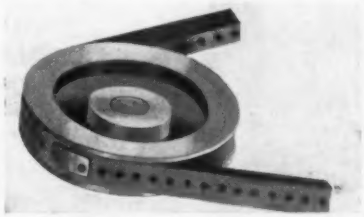
Consists of an underlay drawing aid with a rack and 21 spur gear faces having 6 to 48 simplified teeth in isometric projection. Four diametral pitches—8, 12, 16, and 24. The tooth form is based on the rack of the American Standard 20° involute system. Designed for spur, helical, bevel, internal, herringbone and worm gears; also worms, racks, splines, ratchets and sprockets. Adaptable to other circular forms having evenly spaced projections such as pump rotors, turbines etc. May also be used for perspective projection.

Graphicraft, Westport, Conn.

Circle No. 208 on Reader Service Card

Easy-to-join V-belt

This perforated V-belting, available by the foot, can be joined by using a new fastening device and an ordinary screwdriver. You don't need



jigs or special tools and the joint is said to be stronger than one made in the usual way. Steel fasteners are pre-bent to avoid stressing, the holes are accurately punched and centered on the belt surface. Available in standard sections O-A-B-C in full rolls or handy package assortments. Fits all standard sheaves.

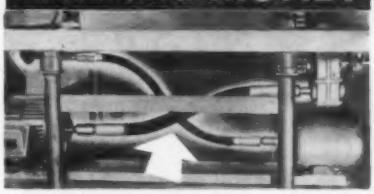
Rockwood Pulley Mfg. Co., New York, N. Y.

Circle No. 209 on Reader Service Card

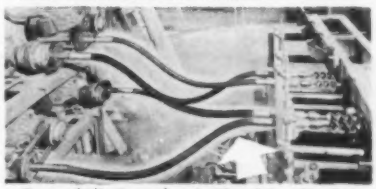
Redesigned squirrel-cage motors

Built for heavy duty industrial applications, Type RP polyphase motors feature compact fabricated steel plate enclosures that have great mechanical strength and high resistance

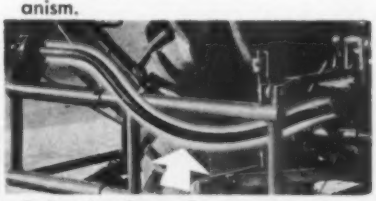
Here's how **Elliott**
Flexible Shafts are Saving TIME and MONEY



Two Elliott Standard Flexible Shafts drive special processing machine and vibrator operating simultaneously Flexible Shafts isolate vibration of table from motors.



Four ¾" Standard Flexible Shafts used in special production machinery in box manufacturing company eliminate parts and intricate mechanism.



Safety is enhanced, appearance improved by coupling bale loader to tractor's power take-off with a Standard Flexible Shaft. Separate gas engine for loader is eliminated.

One Elliott Flexible Shaft assembly can replace many parts, saving assembly time and labor. In one application, a Flexible Shaft for a textile machine replaced 50 parts, reduced cost of original mechanism by two-thirds.

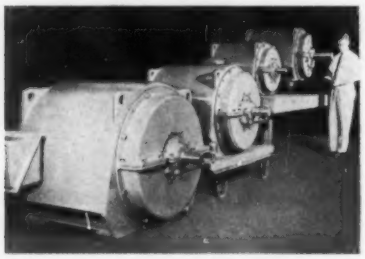
Write for our Catalog **263**

'FLEXIBLE SHAFT DATA FOR DESIGNERS'

B.W. ELLIOTT MFG. CO., INC.
251 State St., Binghamton, N. Y.

Circle No. 13 on Reader Service Card

to corrosion. Four lifting eyes are built-in as integral parts of the frame ends. The flat steel end plates are built in two sections for easy bearing inspection. Whole enclosure is drip-proof. Windings are of pre-



formed copper strip. Coil ends and lead connections are permanently brazed. Both stator and rotor core are constructed to permit radial as well as transverse circulation, which dissipates heat effectively. Available voltages are 440, 550, 2300, and 4160 volts, 60 cycles. Entire range of ratings, 250 through 1000 hp, can be supplied with full load speed of 3500, 1750, or 1160 rpm; 870 and 690 rpm motors are available through 700 hp and 575 rpm motors through 500 hp. Sleeve bearing models can be had in the entire range of ratings and speeds; ball bearing models through 400 hp, all speeds, and through 900 hp at some of the lower speeds.

Wagner Electric Corp., St. Louis, Mo.

Circle No. 210 on Reader Service Card

Synthetic chain lubricant

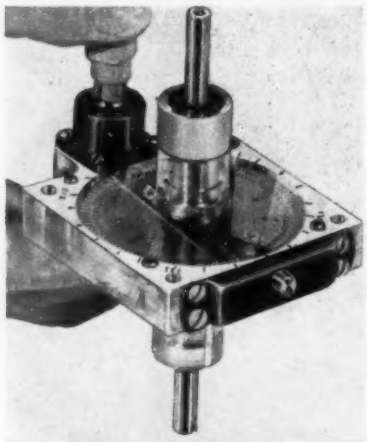
Called Anderol L-732, this semi-fluid lithium grease has a medium viscosity diester oil base and may be applied by grease gun or brush. Temperature range is from —65 to 300 F, with good adhesive and rust resistant characteristics. Comes in 1 lb and 5 lb cans, 14 oz cartridges, and 35, 100 and 400 lb drums.

Lehigh Chemical Co., Industrial Lubricants Div., Chestertown, Md.

Circle No. 211 on Reader Service Card

Dynamic torquemeter

Believed by its makers to be one of the most sensitive torquemeters available, #782 Gram-Torquemeter reads values from ¼ to 100 gm-cm at speeds from 0 to 5000 rpm in both directions. Three ranges—10, 25 and 100 gm-cm full scale. Clear acrylic housing permits reading from either



side. Both dial and pointer rotate, resulting in only 10 gram (plus coupling) weight to connected load. Movement is a balanced dual spring, direct-reading element—no gears—through a 325° scale, 5¾ in. long. Internal stops protect against overload. Accuracy 3%. Overall length 4¾ in. Built in "pip" voltage coil triggers a strobe on each revolution

WHAT'S YOUR PROBLEM?

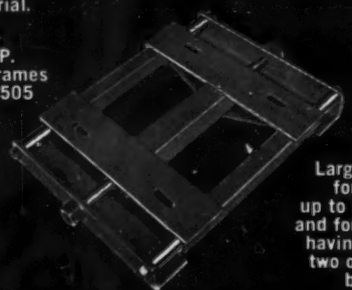
Is it any of the following?

- Diminishing output due to a progressive drop in rpm.
- Too much down-time because of the need for frequent adjustment due to belt stretch.
- Excessive maintenance time and expense.
- Poor belt and bearing life.
- A drive in an inaccessible or isolated location.
- A high-ratio short-center drive.

MOUNTING THE MOTOR ON AN "AUTOMATIC"® BASE MAY PROVE TO BE A SIMPLE AND ECONOMICAL SOLUTION

Motor mounting position and direction of pulley rotation are immaterial.

Stock Sizes ¼ to 125 HP. for NEMA frames 56 through 505 and 445-U



Larger Sizes for motors up to 500 HP. and for motors having one or two outboard bearings.

AUTOMATIC MOTOR BASE CO.
WINDSOR, N. J.

Circle No. 4 on Reader Service Card

SIMPLIFY YOUR RIGHT ANGLE POWER TRANSMISSION PROBLEMS . . .

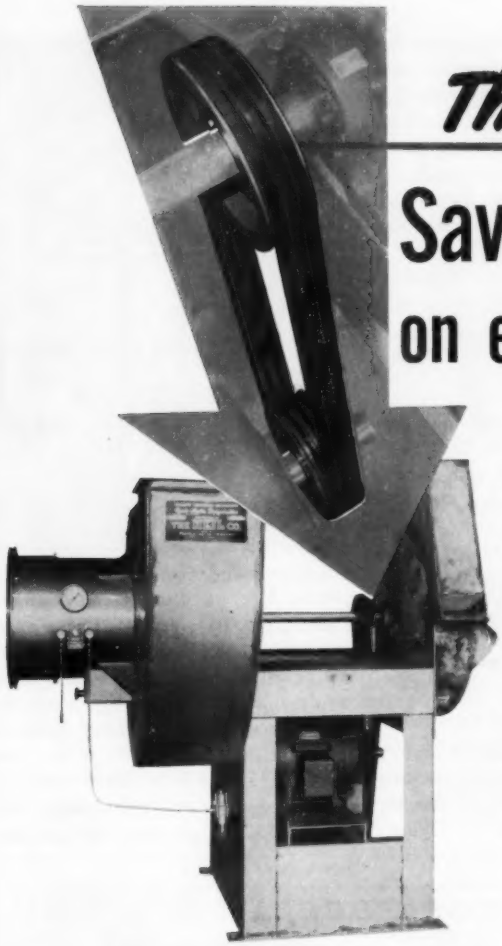
YOUR DESIGN DESERVES THE CROWN GEAR "PACKAGE".

• Totally enclosed Aluminum Alloy Housing • 316 Stainless Steel Shafts • Double Sealed Ball Bearings • Hardened Steel, Spiral Bevel Gears • Choice of 4 or 5 Mounting Positions • Ratings from ¼ through 2 H.P. • 1:1 or 2:1 Ratio optional

Contact your local distributor or write direct for new catalog . . .

CROWN GEAR
320 PARK AVE., WORCESTER 10, MASS.
A Division of Harrington & Richardson, Inc.

Circle No. 9 on Reader Service Card



This New V-Belt Drive

Saved the Heil Co. $40 on every Dehydrator Unit

When Cyclo-Matic Dehydration Units were recently redesigned for greater flexibility in handling different kinds of materials, The Heil Co. engineers decided to incorporate separate motors to drive the main fan and cooling fan, the compressor pump, oil pump, and revolving drum, all of which had previously been driven from one motor.

With the greater number of drives involved, The Heil Co. engineers called in a Gates Representative to see if any savings were possible on drive costs through use of new Gates Super High Capacity V-Belt Drives. Here are the savings that were realized . . .

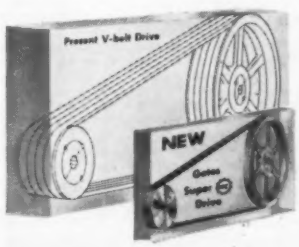
SAVED COST: On the original main drive alone, cost of conventional-type drive was $128.30. On the new main drive, Super HC High Capacity Drives cost only $88.26 — a saving of $40.04 on each main drive! While cost savings on auxiliary drives were not appreciable, additional benefits were reaped here through . . .

SPACE AND WEIGHT SAVINGS: Up to 62% saving in space, and as much as 32% saving in weight, have been realized over and over — not only by The Heil Co., but by hundreds of other manufacturers who have put Gates Super HC High Capacity V-Belt Drives on their products. You can do the same —just by contacting your Gates Representative.

AVAILABLE NATIONWIDE — Gates Super HC High Capacity V-Belt Drives are stocked in key industrial centers throughout the United States and Canada. You'll find your nearby Gates Representative listed in the Yellow Pages of your phone book. Ask him for your free copy of *The Modern Way To Design Multiple V-Belt Drives.*

The Gates Rubber Company, Denver, Colorado

Gates *World's Largest Maker of V-Belts*



Gates Super HC V-Belt Drives

HIGH CAPACITY

same hp capacity in smaller package

TPA540

Circle No. 15 on Reader Service Card

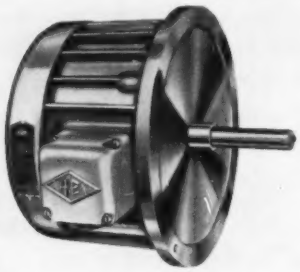
to read rotating torques over 100 rpm. Comes complete with 8 ft. shielded cord and coupling accessories, for $98.

Power Instruments, Inc., Skokie, Ill.

Circle No. 212 on Reader Service Card

Machine tool motors

The 1400 Series, with a new frame, are now available in two new ratings of 15 hp and 20 hp, in addition to the previous series of ½ hp through 10 hp. Vibrationless running makes



the series suitable for precision machine tools. Rotors are dynamically balanced between two heavy duty ball bearings. Radial air gap design with a light, thin, low inertia rotor provide smooth-start, quick-stop operation. Fin-type cast aluminum frames dissipate heat efficiently. All parts made to close tolerances. Available in totally enclosed fan-cooled and totally enclosed type for continuous or intermittent duty.

Reuland Electric Co., Alhambra, Calif.

Circle No. 213 on Reader Service Card

Helical geared reducer

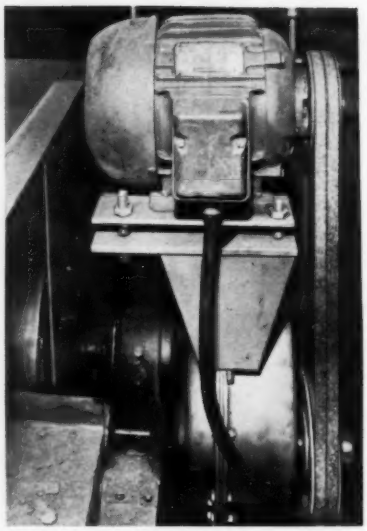
The new model 221 Optimount provides a wide selection of ratings in the 1/6 to 3/4 hp input range. Like the larger models, the 221 size can be horizontally or vertically base mounted, or shaft mounted—to meet any mounting conditions—from stock supplies.

Boston Gear Works, Quincy Mass.

Circle No. 214 on Reader Service Card

Motor mounts

Compact, all steel, pre-drilled weldments are for mounting any rerated NEMA motor (½ to 30 hp) directly to Falk shaft-mounted, flange-



mounted and screw conveyor drives. With foot-mountings, motors within the rated capacity of the reducers can be positioned almost anywhere around the perimeter of the reducer. Adjusting screws in the base plate tension the V-belts. Used with the correct drive, belt pull at the headshaft bearings is reduced to zero.

The Falk Corp., Milwaukee, Wis.

Circle No. 215 on Reader Service Card

Is one of these Drive Problems YOURS

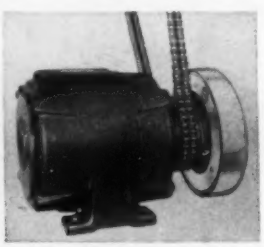
- ✓ *Smoother High-Inertia Starts*
- ✓ *Excessive Loads*
- ✓ *Controlled Acceleration*
- ✓ *Dynamic Braking*
- ✓ *Partial or Full Stall*

You need

GLEASON-TORMAG® Magnetic DRIVES

Here's dependable *drive protection* that can save you money. The new GLEASON-TORMAG Magnetic Drive on your equipment provides frictionless, shockless drive, dependable controlled torque, high-slip or continuous stall operation, smoother cushioned starts, . . . a combination of advantages achieved in no other type of drive.

Uniquely simple in design and construction, operating through eddy currents developed by permanent magnets, GLEASON-TORMAG Drive delivers high efficiency at rated horsepower under full operating loads. No power loss in fluids, or particles or in mechanical friction. Can be used as an "in line" or "take off" drive with flexible couplings, chains, sprockets, belts. Standard sizes range from 1 to 10 H.P., at 1750 RPM. Also Custom-engineered in fractional, and up to 30 H.P. Write on company letterhead for new catalog No. TP260.



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Representatives in Principal Cities in U.S. and Canada.

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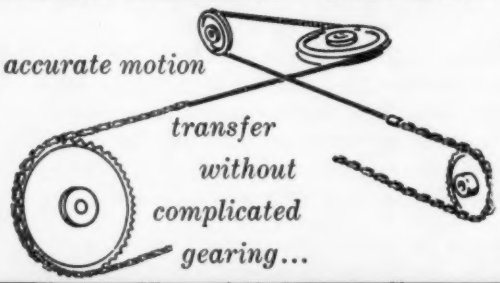

SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance —wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials.

NEW CATALOG

Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

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129 East Montecito • Sierra Madre, California

T. M. REG.

Circle No. 38 on Reader Service Card

Motion safety switch

Switch is designed to be driven by any machine or equipment that works continuously. Connection to a driven shaft is by a small chain drive. Through a pair of bevel gears, a horizontal paddle wheel revolves in a body of oil inside the switch casing when the driving machine is working normally. The movement of the liquid tilts a vane fastened to a horizontal shaft, the end of which is a half round cam surface. A hinged leaf is tilted with the tilting of the vane, but rests on the flat surface of the cam when the vane hangs vertically in the idle position. Movement of the hinged leaf when the vane falls idle actuates a micro switch, either to open or to close a circuit. Said to require little attention and be almost foolproof, the complete switch is 9¼ in. high by 9½ in. wide and can be driven in either direction at 40 or 100 rpm.

Fuller Co., Catasauqua, Pa.

Circle No. 216 on Reader Service Card

Spring set solenoid brake

This spring set, solenoid released brake, called the Style "H" 44, is for

size 40 frame motors and has a torque rating of 3 lb ft. Available in ac and dc, and with a drip-proof enclosure. Designed for use on small hoists, weighing devices etc.

Stearns Electric Corp., Milwaukee, Wis.

Circle No. 217 on Reader Service Card

New type hydraulic motor

Special performance characteristics of this motor are its low speed and high torque, obtained by the novel use of a gerotor mechanism. Motors develop up to 3,300 lb in. of torque at 1500 psi, with intermittent pressures up to 2,000 psi, by new orbit principle. Top speed with the smallest power element is 800 rpm. It develops 500 lb in. of torque at 1500 psi. Overall length of the housing varies from 5.25 in. to 6.50 in. depending on the thickness of the power element. Diameter is approxi-

mately 3.25 in. Motors are instantaneously reversible and come with 4 types of mounting, 3 port sizes and with 6 selections of power element.

Char-Lynn Co., Minneapolis, Minn.

Circle No. 218 on Reader Service Card

Weld-on sprocket hubs

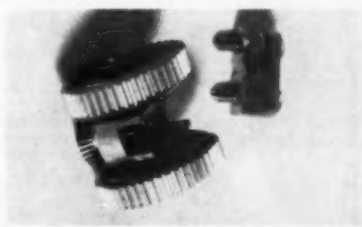
A simple, do-it-yourself welding process allows dealers and machine shops to carry a larger variety of sprocket sizes with a smaller inventory. Three hub sizes cover most shaft sizes in increments of ⅛ in. Keyway, set screw included. For dealers, a display board comes free with an initial order of 19 sprockets and 26 finished hubs.

Dalton Gear Co., Minneapolis, Minn.

Circle No. 219 on Reader Service Card

Hollow shaft differentials

A new feature introduced into this line of precision miniature bevel gear differentials is a V-block clamp which is an integral part of the spider assembly. The clamp provides positive locking when tightened by 2 screws, but will not mar or distort the shaft. Putting the clamp directly over the



center of the hollow shaft differential allows considerable reduction in overall lengths, and permits changing axial position or length of shaft without

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FROM STOCK!

IN BRASS AND STEEL
14½° AND 20°
PRESSURE ANGLES
WITH STANDARD OR WIDE FACE WIDTH

A complete line of industry standard gear rack from 3 to 64 Pitch

Available Through Leading Power Transmission Distributors

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34th and Clearfield Streets
Philadelphia 32, Pennsylvania

Circle No. 17 on Reader Service Card

PRODUCTS *continued*

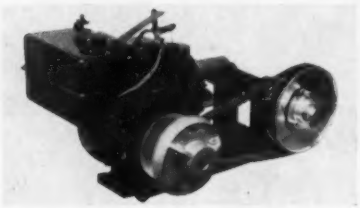
replacement of differential. Stainless steel construction, double ball bearing suspension on all bevel gears. Precision Class 2 gears throughout (pitch 127 to 96), with 5 minutes maximum backlash. Sizes for shaft diameters from .0550 in. to .1875 in.

Empire Flight Components, Inc., Bellmore, N. Y.

Circle No. 220 on Reader Service Card

Automatic transmission unit

The Vari-Dyne "400" provides inexpensive automatic transmission of power for 2 to 4 hp gasoline engine-driven vehicles and equipment such as scooters, lawn mowers etc. At engine idling speed, the drive pulley rotates within the slack belt. With acceleration, the drive pulley engages the belt to start the load smoothly. Speed ratios between the two pulleys range from 3:1 at start to 1:1 at operating speeds. After the vehicle is underway, ratios change automatically to compensate for varying speeds and loads.



Salsbury Corp., Los Angeles, Calif.

Circle No. 221 on Reader Service Card

Mercury switch

Low cost 2 amp mercury switch is shockproof, waterproof and operates on any axis. Called the HG426 MI, nominal diameter is .500 in. and nominal length 1 11/16 in. Both switch and leads are potted in rigid PVC for complete moisture protection. Price is 50 cents each in OEM quantities.

Gordos Corp., Bloomfield, N. J.

Circle No. 222 on Reader Service Card

Gasket material

This material, called Armstrong N0784, is a special Buna N rubber compound, maintains its hardness in oil up to 350. It is said to have a wider temperature range than some of the polyacrylic materials now used. Suitable for automobile transmission seals, oil seals etc.

Armstrong Cork Co., Lancaster, Pa.

Circle No. 223 on Reader Service Card

Throttle positioning system

This 3-unit remote throttle positioning system for marine, jet and automotive engine testing was formerly manufactured only for the military. It consists of a throttle quadrant, amplifier and servo positioner. The servo uses magnetic particle clutches for accuracy of positioning, proportional torque limiting and fast response. The throttle quadrant offers coarse or fine adjustment, limit and idle stops and a manual override for easy synchronization of quadrant and servo. The tube-type amplifier has standard components for simple maintenance.

Lear, Inc., Industrial Products, Grand Rapids, Mich.

Circle No. 224 on Reader Service Card

NEED SPECIAL PULLEYS?

NAGEL-CHASE CAN HELP!

When you need FHP V-Belt Pulleys of special design, you can do better by consulting Nagel-Chase. This company has specialized in FHP pressed steel V-Belt pulleys for more than a quarter century.

The step-down pulley illustrated is a typical example of many especially designed pulleys Nagel-Chase has engineered for use on compressors, washers, dryers, lawn mowers, tractors and agricultural equipment.

Whenever there's a V-Belt Pulley on your new model or product, be sure to consult Nagel-Chase.

Write for Catalog

Special low cost step down pulley designed and produced in quantity by Nagel-Chase Stamped metal hub with built-in oil reservoir replaces usual solid metal hub.

The NAGEL-CHASE MFG. CO. 2815 No. Ashland Ave. Chicago 13, Ill.

Circle No. 25 on Reader Service Card

5 Reasons Why Veelos Adjustable V-Belts Are Better for Your Drives

1. *Balanced Construction* assures faster, cleaner work. Each link and stud is identical in size and weight; no spots of varying density.
2. *Less Vibration*—up to 90% less—in machines with Veelos-equipped drives. Wear on bearings and machines is greatly reduced.
3. *Cooler Running* assures long life. Constant circulation of air around and between Veelos links prevents internal heat build-up.
4. *Greater Flexibility* reduces slippage. Each link moves around sheave independently, maintains full contact; permits shorter centers, smaller sheaves.
5. *Simple Installation* "knocks out" down-time. Saves up to 50% installation time on outboard bearing drives. No resetting, tilting or moving motors with adjustable Veelos.

Write for free Veelos Data Book

NEW!

VEELOS TOOL

Provides a fast, safe way to couple and uncouple link v-belt. Every stockroom attendant needs one . . . every maintenance mechanic needs one. Order from your Veelos distributor or write for illustrated bulletin.

VEELOS THE BALANCED LINK V-BELT

MANHEIM Manufacturing & Belting Company Manheim 9, Pa.

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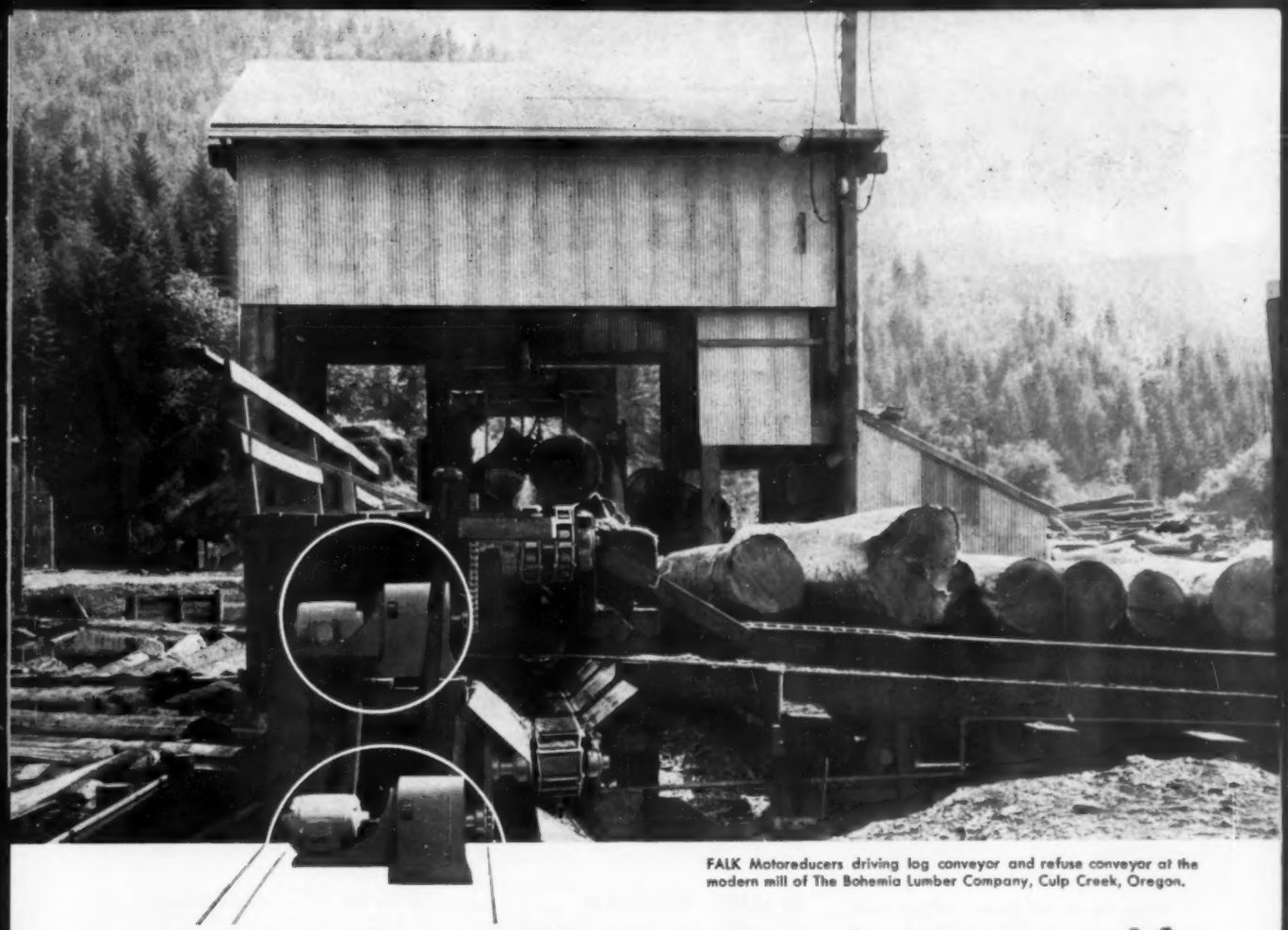

FALK Motoreducers driving log conveyor and refuse conveyor at the modern mill of The Bohemia Lumber Company, Culp Creek, Oregon.

FALK *all-steel* Motoreducers give you longer service life

Whether your load conditions are normal or heavy, the extra rigidity of all-steel construction (more than twice that of cast iron) maintains better alignment of revolving elements under load...a vital factor in prolonging the service life of gears and bearings.

And if your installations are subject to shock loads, or accidental external impacts, you're way ahead when you install Falk All-Steel Motoreducers. These rugged units do not destroy themselves by tearing off their feet under jamming overloads, nor are their housings subject to cracks which both dissipate the vital lubricant supply and allow revolving elements to get out of alignment.

All-steel construction is one of the built-in extras that you get in Falk Motoreducers. Others include: (1) inherently stronger gear teeth (by AGMA standards), thanks to exclusive Falk extra-depth, high pressure angle helical gears; (2) maximum mechanical efficiency (98½% per gear mesh, under full load); (3) your choice of standard units (horizontal, vertical or right angle) to fit your precise requirements.

HORSEPOWER RANGE: to 75 hp . . . STANDARD OUTPUT SPEEDS: 780 rpm (high) to 1.2 rpm (low).

Prompt delivery from distributor stocks, or from warehouse or factory. Ask your Falk Representative or Authorized Falk Distributor for ***Bulletin 3100.***

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MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

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FALK

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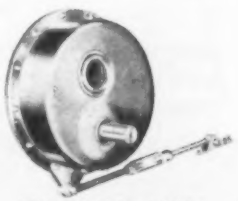
Take your choice of all-steel drives when you specify Falk

THE FALK ALL-MOTOR MOTOREDUCER
...the original All-Motor unit



THE ALL-STEEL FALK SHAFT MOUNTED DRIVE

Torque ratings to 44,000 lb-in at low speed shaft. Also available in flange-mount design.

FALK and ALL-MOTOR are Registered Trademarks.

LITERATURE *on drives and components*

To get free copies of the following literature, use the Reader Service Cards bound into this issue.

ROTARY GEAR SHAVING MACHINE . . . Red Ring Model GCX-24 will handle spur or helical gears up to 25½ in. OD in the 2 to 16 diametral pitch range. Shows spec. and capacity tables. Illustrates new tunnel-type cast iron column and base design by which reciprocating work table can be traversed clear of the shaving cutter to ease loading and unloading. *National Broach and Machine Co.*, Detroit, Mich.

Circle No. 300 on Reader Service Card

SCREW CONVEYOR DRIVE . . . double-reduction, shaft-mounted reducer drive for direct application to screw conveyors is the subject of 4-page Folder 2718. Drives in six sizes with ratios of 15:1, 20:1, and 24:1 for motors up to 30 hp. Folder lists sizes in relation to screw diameters and gives selection data. *Link-Belt Co.*, Chicago, Ill.

Circle No. 301 on Reader Service Card

RULON AND TEFLON PARTS . . . properties of the two materials are compared and typical applications shown in 4-page Brochure 9572. Illustrates numerous Rulon parts for use as lube-free bearings, thrust washers, O-rings and other applications requiring low deformation under load, low coefficient of friction, and high compressive strength. Engineering, production and laboratory testing facilities also shown. *Dixon Corp., Plastics Div.*, Bristol, R. I.

Circle No. 302 on Reader Service Card

MECHANICAL ADJUSTABLE DRIVES . . . Bulletin GEA-6806, 16-pages, describes the new Polydyne line. Discusses principles of operation, new features and includes mounting positions, rating tables, and lists accessories. Stresses the advantages of mechanical adjustment and how to specify and select suitable units. *General Electric Co.*, Schenectady, N. Y.

Circle No. 303 on Reader Service Card

SOLID FILM LUBRICANT . . . it can be applied by spraying, dipping or brushing, will air dry in 15 to 20 minutes and provides a durable solid film lubricant on most metallic surfaces. Called Surf-Kote A-1290, Bulletin SL-126 gives all the details on this molybdenum disulfide lubricant. *Hohman Plating & Mfg. Inc.*, Dayton, Ohio.

Circle No. 304 on Reader Service Card

ELECTRIC MOTOR CATALOG . . . contains much information, condensed into 14 pages, on selecting and specifying fractional and integral hp motors for original equipment. Details dimensions, construction, and prices of line and describes modifications which are available. *Doerr Electric Corp.*, Cedarburg, Wis.

Circle No. 305 on Reader Service Card

BEARING CLEANING . . . and relubricating equipment for ball and roller bearings is the subject of 8-page illustrated brochure. Equipment described will handle bearings from ¼ in. to 14 in. OD and will clean most bearings with the shield in place. Cleaning is said to have saved one manufacturer $100,000 yearly in plant maintenance. *Bearing Inspection, Inc.*, Huntington Park, Calif.

Circle No. 306 on Reader Service Card

STOCK SPROCKETS . . . Catalog #30 includes recent additions to the line, bringing up the total number of sizes carried to over 2200. Sixty pages of tabulated information, which includes price lists and dimensioned drawings, on sprockets and matching chains. Also explains mounting procedures. *Martin Sprocket & Gear, Inc.*, Arlington, Texas.

Circle No. 307 on Reader Service Card

COMPLETE LINE CATALOG . . . Bulletin 23103 describes and illustrates a complete line of mechanical power transmission equipment. Products covered include variable speed drives of both motion and stationary control types; conventional V-belt and Ultra V-belt drives; timing belt drives; flat belt pulleys; flexible and rigid couplings; adjustable motor bases; ball bearing pillow blocks, flange and take-up units; solid and split sleeve pillow blocks; cotton-card drives; cotton cleaner drives; bushings. *T. B. Wood's Sons Co.*, Chambersburg, Pa.

Circle No. 308 on Reader Service Card

REDUCER GUIDE . . . this shirt-pocket selector gives the correct model Radicon reducer for any combination of input speed, ratio or output speed, and required capacity. Also gives 20 key dimensions for the selected unit. *Foote Bros. Gear & Machine Corp.*, Chicago, Ill.

Circle No. 309 on Reader Service Card

MOTOR RELIABILITY PROGRAM . . . to provide precision miniature electric motors to specified reliability levels for critical applications, is described in a 6-page booklet. Deals with design, production and testing facilities. *Globe Industries, Inc.*, Dayton, Ohio.

Circle No. 310 on Reader Service Card

CHAIN CATALOGS . . . from British Renold and Coventry Chain Co. cover roller chains and spare parts for the B.S. and A.S.A. Series (No. 316/449); standard stock series chain drives up to 140 hp (No. 116/78); and chains and accessories for industrial applications (No. 116/86). *General Chain Sales Corp.*, New York, N. Y.

Circle No. 311 on Reader Service Card

ROTATING TRANSMISSION . . . called Roto-mission is a shaft-mounted differential planetary gear transmission, said to provide up to six times more torque than comparable units, with high control flexibility and compact size. Capacities from fractional through 60 hp, reductions up to 270:1. Eight-page bulletin IR-60 furnishes cross-section details of construction tables of ratios and ratings, illustrations of design applications and data on progressive overload capacity. *Airborne Accessories Corp., Industrial Div.*, Hillside, N. J.

Circle No. 312 on Reader Service Card

ROLLER CHAIN AND SPROCKETS . . . specification guide (36-pages, Catalog Section 320) lists sprockets stocked in 1013 sizes from ⅜ to 2½ in. pitch, and from 8 to 112 teeth. Includes styles B and C sprockets, style A plate sprockets; quick-demountable sprockets and bushings; roller chains in all standard sizes. Gives details on weld-on steel hubs to convert style A sprockets to B or C, or to change style B to C. *Fort Worth Steel & Machinery Co.*, Fort Worth, Texas.

Circle No. 313 on Reader Service Card

MINIATURE FLEXIBLE COUPLINGS . . . data sheets and price list cover complete line, with 12 new models and/or sizes including a ⅝ in. diameter coupling in both split hub and pancake types. All types available in a large variety of bore sizes. *Dial Products Co.*, Bayonne, N. J.

Circle No. 314 on Reader Service Card

VIBRATION CONTROL BROCHURE . . . describes complete line of products to excite, measure and control vibration. Covers principles of vibration testing and gives specifications of electrodynamic vibration exciters, electrohydraulic shaker systems and sine and random motion electronic control consoles. Bulletin 420-G, 16 pages. *MB Electronics*, New Haven, Conn.

Circle No. 315 on Reader Service Card

CLUTCHES AND BRAKES . . . a comprehensive 32-page catalog on air tube disc clutches and brakes. Contains complete specification data and many photographs covering all types of applications. Gives suggested clutch and brake arrangements to help in design or unusual applications. *Wichita Clutch Co., Inc.*, Wichita Falls, Texas.

Circle No. 316 on Reader Service Card

GEAR INSPECTION MACHINES . . . Bulletin C60-8 describes and illustrates Model GRF automatic gear checkers and classifiers, Models GRJ and GRH simplified gear rolling fixtures that include optional low cost chart recorders, Model GSC gear speeders equipped with electronic noise indicators, and a precision involute profile checking machine designed especially for checking gear shaving cutters. The involute checker is described in detail. *National Broach & Machine Co.*, Detroit, Mich.

Circle No. 317 on Reader Service Card

DIHEDRAL SPINDLE COUPLINGS . . . engineering, application, capacity and dimensions in 12-page Catalog No. 70. Also covers Series D-100 and D-1000 Dihedral gear type flexible couplings. Illustrates uses on mills, etc. Two page question, answer and sketch sheet for easier ordering. *Ajax Flexible Coupling Co., Inc.*, Westfield, N. Y.

Circle No. 318 on Reader Service Card

SPIROID GEAR CATALOG . . . Supplement Catalog #22 covers a new line of precision Spiroid gears, manufactured under license from the Spiroid Div. of Illinois Tool Works. Complete specifications, detailed drawings and prices on high performance worms and gears available for immediate delivery. *PIC Design Corp.*, East Rockaway, N. Y.

Circle No. 319 on Reader Service Card

BALL BEARING UNITS . . . Catalog 454 presents complete company line with technical and engineering data, specifications, illustrations, diagrams and typical applications. Copy stresses permanent seal, pre-lubrication, self-aligning and zone hardening features. *Seal Master Bearing Div., Stephens-Adamson Mfg. Co.*, Aurora, Ill.

Circle No. 320 on Reader Service Card

VARIABLE SPEED DRIVES . . . Catalog lists drives for fractional hp applications. Includes diagram, tips on installation and answers general questions on the use of mechanical variable speed drives. *Zero-Max Co.*, Minneapolis, Minn.

Circle No. 321 on Reader Service Card

GEAR GRINDING FACILITIES . . . sixteen page bulletin (No. 100) describes equipment for precision grinding, intricate profiling (ID or

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LARGE OR SMALL HEAT TREATED OR PLAIN

SIMONDS has over 60 years' experience in cutting quality industrial gears. We can supply any type of gear in cast or forged steel, gray iron, bronze, Meehanite, rawhide or bakelite in a full range of sizes adaptable to the material. Also heat-treated, case or flame hardened gears of carbon or alloy steel. Send us your requirements for quotation.

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SIMONDS' facilities can produce any type of custom gear from your blanks if you prefer. Same quality . . . same prompt service.

QUALITY GEARS FOR OVER 65 YEARS

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Also stock carrying distributors of Ramsey Silent Chain Drives and Couplings; and industrial V-belts.

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THE SIMONDS GEAR & MFG. CO.

LIBERTY at 25TH PITTSBURGH 22, PA

Circle No. 29 on Reader Service Card

OD), gear grinding and shaving to AGMA standards, and inspection with laboratory instruments. Lists capacities and types of work possible. *Enterprise Div., Michigan Tool Co.*, Detroit, Mich.

Circle No. 323 on Reader Service Card

GEAR AND PINION COMBINATION . . . units die cast in zinc are featured in 10-page Catalog 3001-B. Hundreds of possible combinations for small, light-load gearing. Engineering drawings and tables give pitch, number of teeth, pitch diameter and other important dimensions. *Gries Reproducer Corp.*, New Rochelle, N. Y.

Circle No. 324 on Reader Service Card

ADJUSTABLE DRIVE . . . may be driven from either end and will provide ratios between input and output that vary from zero to infinity regardless of input speed changes. Bulletin 550 covers drives from 1/15 to 5 hp. Twelve pages, includes specification tables and line drawings. *Graham Transmissions Inc.*, Menomenee Falls, Wis.

Circle No. 325 on Reader Service Card

CAM MANUFACTURING . . . Brochure explains how continuously generated, mathematically accurate cams are made by a new method, at a cost much below other less accurate methods. Gives blanks for selection and indicates information needed for ordering. *Stelron Cam Co.*, Paramus, N. J.

Circle No. 326 on Reader Service Card

AC/DC GENERATORS . . . and motor generators range from ½ through 15 kva, ac, or ½ to 3 kw, dc. Bulletin 700 (A, B) lists a variety of generator applications. Motor generators produce direct current from ac power supply; single-phase alternating current from dc. *The Leland Ohio Electric Co.*, Dayton, Ohio.

Circle No. 327 on Reader Service Card

PROXIMITY SWITCH . . . is said to be the lowest priced and smallest on the market. Two-page flyer, illustrated with photographs and diagrams lists operating specifications, power handling capacity, differential, size and price. Some applications are suggested. *Tann Controls Co., Div of Tann Corp.*, Detroit, Mich.

Circle No. 328 on Reader Service Card

MINIATURE ISOLATOR . . . weighs less than ½ oz., has 7 load ranges from 0.38 to 4 lbs per mount and provides isolation through 10 degree inclinations from horizontal. Bulletin 60-07 covers Series L21 and L22, gives cutaway diagrams, performance curves and lists sizes available. *Barry Controls, Inc.*, Watertown, Mass.

Circle No. 329 on Reader Service Card

DRIVE CATALOG . . . opens with an introduction on the advantages of Positive Drives, then devotes the main part of its 48 pages to engineering and selection tables for the five stock pitches available—1/5, 3/8, 1/2, 7/8 and 1-1/4 in. (capacities fractional up to 600 hp). Separate drive tables and hp ratings for each pitch. *Maurey Mfg. Corp.*, Chicago, Ill.

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"CHAIN LUBE"

GOES ON LIKE OIL—STAYS LIKE GREASE

IT'S WATERPROOF. THE PERFECT LUBRICANT FOR ALL CHAIN SIZES. ASSURES LONG, TROUBLE-FREE PERFORMANCE—LOWER MAINTENANCE COSTS. COMBATS RUST AND MOISTURE.

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The following reprints of special reports which have appeared in HYDRAULICS & PNEUMATICS Magazine are available:

WHAT TO LOOK FOR IN AIR VALVES

This 16-page report contains basic designs of directional control, pressure control and flow control valves. Illustrates many different designs and points to remember in selecting a specific design.

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Report helps you select the amount of air you'll need, types and number of compressors, drive motors, auxiliary and protective equipment. Application descriptions and photos. Two-page compressor specifications chart. Eleven pages.

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Plastic tubing, reinforced plastic hose, and fittings are discussed in this six-page report. Charts and nomographs of burst pressures. Photos show how to install nylon tubing.

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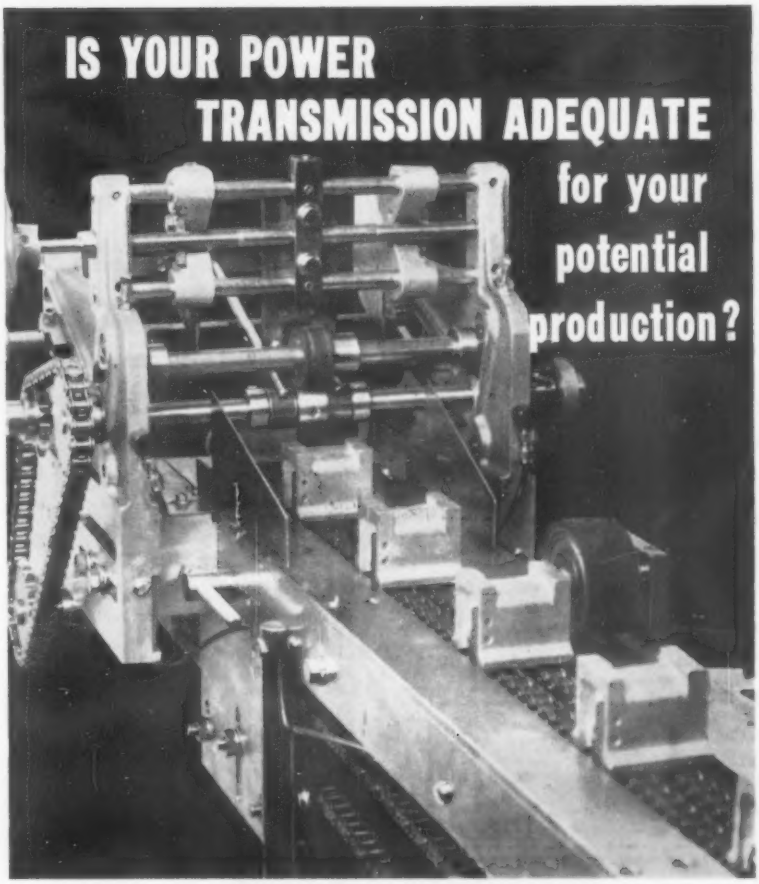

If you're not getting over 98% of the power furnished by the driving sprocket, you're increasing costly production and maintenance time. With Acme roller chain drives, there is practically no loss of ratio of energy between driving and driven members.

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Miniature isolator 328
Barry Controls, Inc.
Drive catalog 329
Maurey Mfg. Corp.

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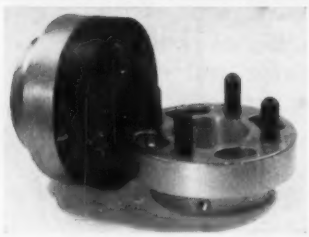

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DECEMBER 1960

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203	209	215	221	227	233	239	245	251	257	263	269	
204	210	216	222	228	234	240	246	252	258	264	270	
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302	308	314	320	326	332	338	344	350
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305	311	317	323	329	335	341	347	353

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4	16	28	40	52	64	76	88	100	112	124	136	148
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8	20	32	44	56	68	80	92	104	116	128	140	152
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10	22	34	46	58	70	82	94	106	118	130	142	154
11	23	35	47	59	71	83	95	107	119	131	143	155
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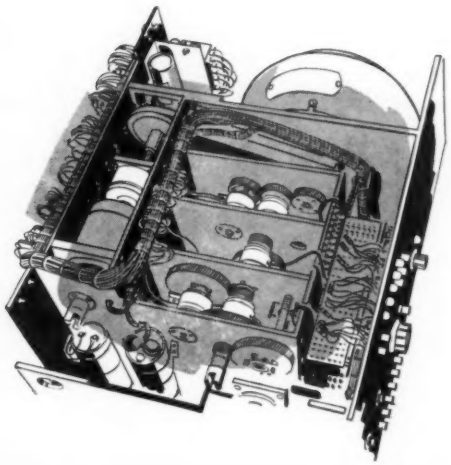

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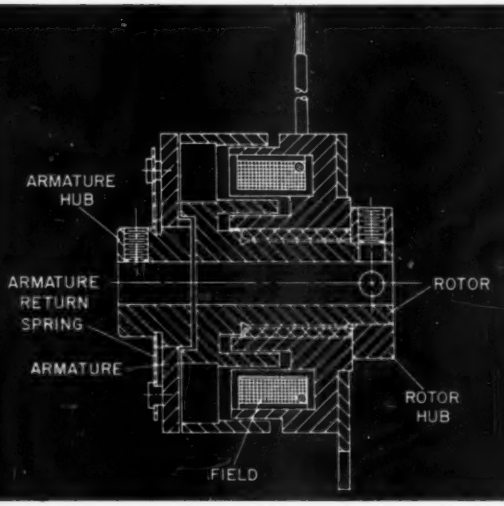

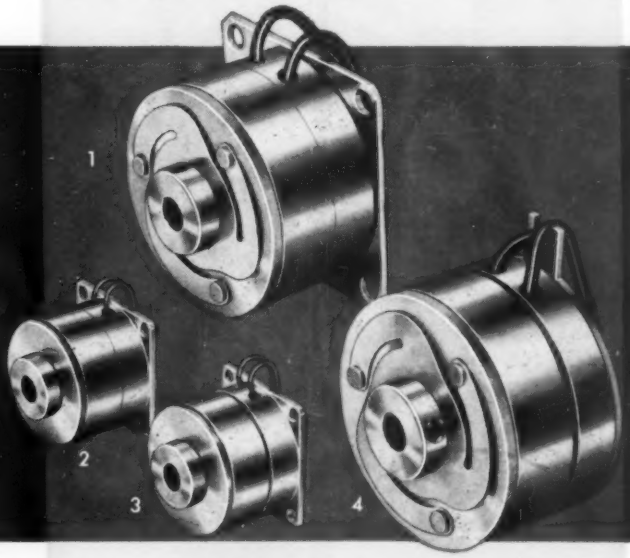

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2 — .875" BRAKE
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